FRATIS Concept of Operations

Assessment of Relevant Prior and Ongoing Research and Industry Practices

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16. Abstract

This report summarizes the state of the practice in freight-related advanced traveler information systems (ATIS) and assesses their relevance to the development of a Freight Advanced Traveler Information System (FRATIS). The report includes relevant government programs and projects, as well as recent technological developments in the private sector which have a bearing on FRATIS. Technologies and projects are grouped into seven key areas: Real-time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight arterials; Planning, Dynamic, and Regulatory Route Guidance; Weather Information (Including Predictive); Terminal Queue Status (Including Video); Appointment Status; Public-Sector Data Output – Performance Measures; and Container Load Matching. Each technology or program is assessed according to functional area, scope/timeframe, benefits and impacts, performance measures, issues, and lessons learned. Overall, the findings support the notion that FRATIS can benefit from an integrated deployment approach which leverages applications and technologies already available in the private sector, while also providing valuable freight performance monitoring to the public sector.

The report also formulates initial performance measures and transformative performance goals for FRATIS, including improved freight travel times; reduced fuel consumption; reductions in criteria pollutant and greenhouse gas emissions; reduced unproductive truck trips; reduced terminal wait times; and improved truck trip safety.

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Executive Summary

This document summarizes the relevant body of prior and ongoing research related to Freight Advanced Traveler Information Systems (FRATIS). In reviewing this work, CS found that the projects and programs may be grouped into seven key areas. These areas correspond to the seven FRATIS Essential Features which were described in the FRATIS Concept of Operations:[1]

- **Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials** represents a significant body of work, especially from the public sector. U.S. DOT and state agency research and demonstrations in this area have been ongoing for well over a decade, and programs are evolving to specifically include more freight-related information. Important advances have been made with programs such as Electronic Freight Management and the Cross-town Improvement Project, both of which provided quantifiable benefits to industry and government. At the same time, the experience with the Cross-town Improvement Project suggests that there are limits to a government systems engineering approach, particularly in the context of a rapidly evolving traffic information marketplace.
- **Planning, Dynamic, and Regulatory Route Guidance** is a more recent development which also has more private sector involvement. The growing penetration of smartphones, combined with sophisticated location-based services and ubiquitous traffic data, is driving rapid advances in the field. However, the most advanced dynamic routing available today focuses on the passenger sector. Large trucks cannot necessarily take the same alternate routings as cars, so there may be an opportunity here to create truly dynamic routing for trucks by leveraging recent advances in dynamic route guidance and customizing routes for commercial vehicles. Dynamic rerouting for oversize/overweight loads, on the other hand, is limited by resource and data constraints and may always require a certain degree of manual intervention.
- **Weather Information (Including Predictive)** includes specialized alerts and warning systems which consider the unique operational characteristics of heavy trucks. Certain weather events – such as high crosswinds – are of particular concern to the trucking community. Moreover, the timing of information delivery and geographic coverage required by truckers may differ from that needed by passenger cars. This is because trucks tend to cover long distances and cross multiple jurisdictions, so drivers may need weather information not only where they are at any given moment, but also 30 minutes or more ahead. Recent developments with the U.S. DOT Road Weather Management Program, as well as research by ATRI looking at weather thresholds for trucks, may prove a valuable data resource for FRATIS.

[1] U.S. DOT, *Freight Advanced Traveler Information System Concept of Operations*, *Final Report v2.1*, April 20, 2012. See Table 3.2, pp. 3-7 to 3-8.

- **Terminal Queue Status (Including Video)** encompasses systems developed to measure and disseminate information about truck queues at terminal gates, including queue length and/or wait time. Systems can range from sensors positioned at key points approaching the terminal gates which can detect when the queue exceeds a certain length, to video cameras that provide a live webcam view of real-time queuing activity. Evidence suggests that terminal video feeds are a popular and valuable information source for the intermodal trucking industry. There are also commercial systems that utilize Bluetooth technology to measure vehicle queues which have been successfully tested at international border crossings and may be applicable to intermodal terminals.
- **Appointment Status** covers systems that use the Internet or mobile technologies to improve the coordination of terminal capacity with truck appointment scheduling. This can smooth out truck arrivals throughout the day, reducing truck queues and taking advantage of times when the terminal is underutilized. This saves time and fuel for truckers, increases draymen's income by allowing more turns per day, and reduces emissions of harmful pollutants from idling trucks. Although many intermodal terminals have adopted such systems, they have not yet been linked to a drayage optimization strategy, which could result in public and private benefits, including reduced operational costs, trip reductions, and improvements in air quality.
- **Public Sector Data Output – Performance Measures** involves the use of truck GPS records to identify truck bottlenecks and travel times on key freight corridors. This is an emerging area that is becoming more widely used as the costs of GPS data come down and industry partners find ways to protect potentially sensitive business information. GPS data that has been scrubbed of identifying information represents a promising way for FRATIS to support public sector freight performance measurement.
- **Container Load Matching** is almost entirely a private sector endeavor, with several software providers offering packages to improve intermodal dray operations, including asset utilization, billing, and overall business processes. However, recent Transportation Research Board research suggests that there are ways to improve dray fleet efficiency through better information sharing. There are some institutional obstacles to dray load matching which need to be fully understood when devising a technological approach to reducing dray inefficiencies. Nonetheless there are probably opportunities to reduce unproductive moves provided the right stakeholders can be convinced to participate.

Figures ES-1 through ES-3 summarize the projects, programs, research, and private sector developments in each of these seven areas. In each circle diagram, the middle circle represents the category of work the projects fall into; the white middle circle describes the key findings in that area; and the blue outer circle represents the programs, products, research, and projects germane to that particular key finding. Note that since there is only one project that is relevant to freight weather information, that feature is shown under Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials in order to simplify the presentation. This convention is carried throughout the rest of this report.

Based on this review of prior and ongoing work, combined with concurrent efforts in this project and additional on-line research, the consultant team has developed a set of proposed goals, performance measures, and transformative performance targets for FRATIS. These goals and benefits will include:

- Improved travel time via a reduction in freight travel times;
- Reduced fuel consumption;
- Reductions in emissions of criteria pollutants and greenhouse gases from freight vehicles;
- Reduced unproductive truck trips, e.g., bobtails;
- Reduced terminal wait times outside the gates; and
- Improved truck trip safety through a reduction in truck-involved accidents.

Figure ES-1. Key Findings and Implications for FRATIS

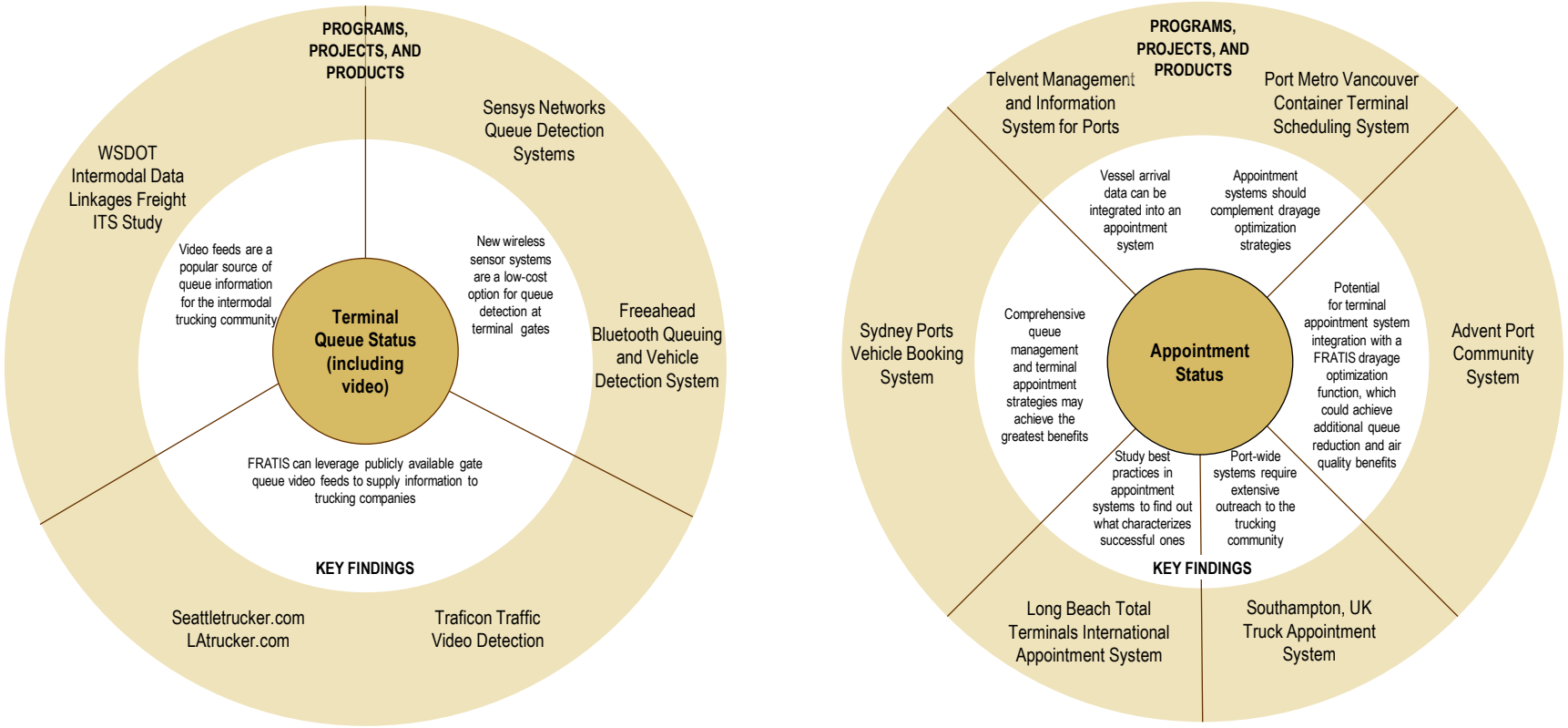
Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials and Planning, Dynamic and Regulatory Route Guidance

Note: Weather Information (Including Predictive) is included here as there is only one relevant project in this field.

Source: Cambridge Systematics, Inc., August 2012.

Figure ES-2. Key Findings and Implications for FRATIS

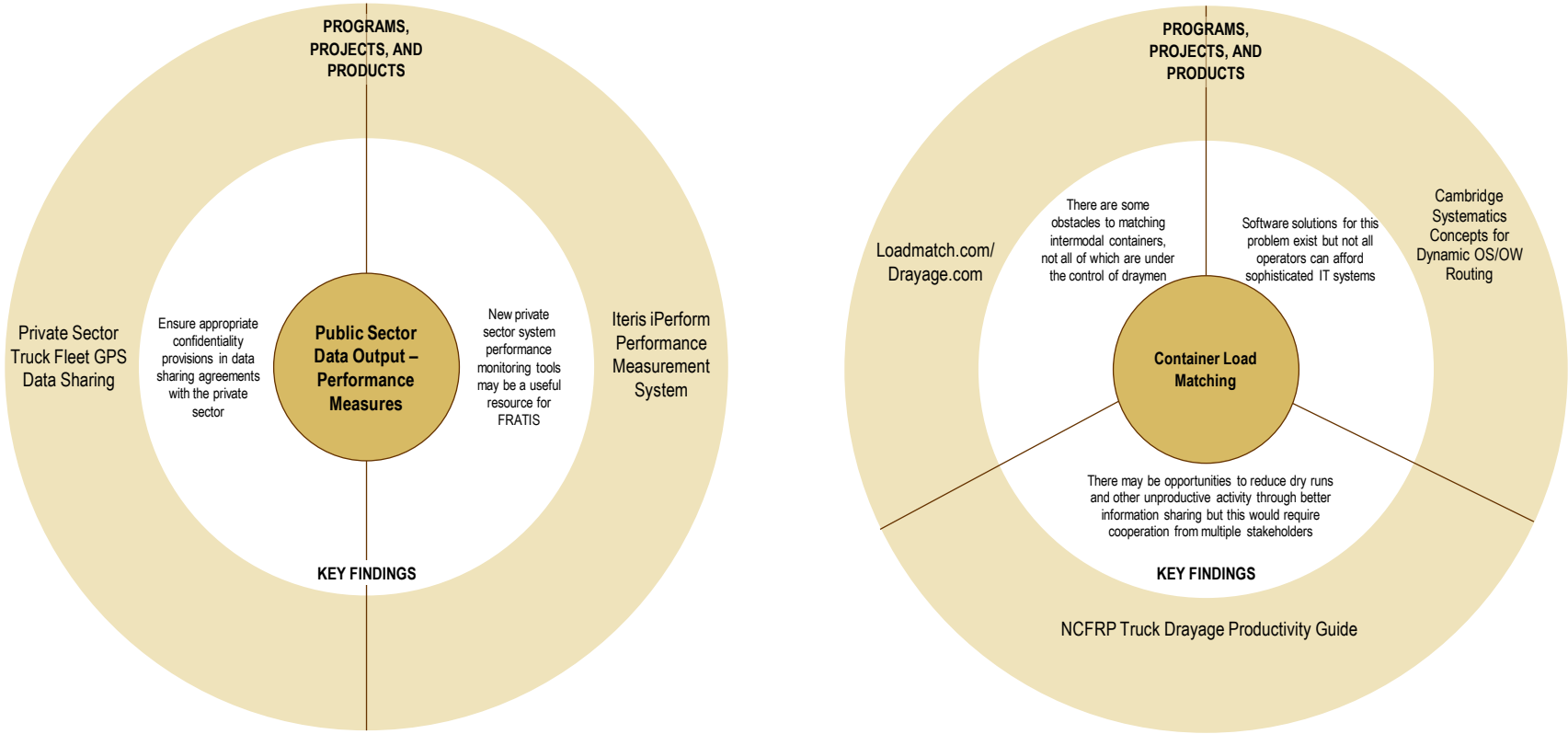
Terminal Queue Status (Including Video) and Appointment Status



Source: Cambridge Systematics, Inc., August 2012.

Figure ES-3. Key Findings and Implications for FRATIS

Public Sector Data Output – Performance Measures and Container Load Matching



Source: Cambridge Systematics, Inc., August 2012.

1.0 Introduction

The FHWA Office of Freight Management and Operations (FHWA-OFM) is developing a Concept of Operations (ConOps) and Functional Requirements for a Freight Advanced Traveler Information System (FRATIS). This project encompasses the ConOps for the freight and commercial vehicle operations (CVO) Dynamic Mobility Applications (DMA), which is part of the larger DMA program presently being developed by FHWA. These Functional Requirements for the FRATIS ConOps programs are leveraging developments in the private sector, including smartphones, DSRC 5.9 GHz, and other technologies to develop a series of future phased deployment packages. These packages are leading the deployment of freight/CVO DMAs, encompassing freight real-time traveler information, truck dynamic routing, automated oversize/overweight planning, and real-time load matching for freight pickups and deliveries.

A key first step in this process is to assess the existing body of work related to Freight ATIS. Understanding the technologies, capabilities, and lessons learned from previous efforts is important to developing the ConOps, which will provide the overall high-level vision for FRATIS, thus enabling later technical specification and development of the FRATIS bundle of applications. This Assessment of Relevant Prior and Ongoing Research and Industry Practices therefore provides a baseline understanding of the current state of the practice in freight traveler information, particularly in those areas that are likely to be key in implementation of FRATIS. For instance, a recent test of truck DSRC 5.9 GHz communications to other vehicles and to roadside infrastructure in New York State successfully demonstrated this technology in the trucking environment. This is important since the U.S. DOT is committed to the use of DSRC 5.9 GHz communications for the next generation of ITS applications. Recent research in the Connected Vehicle, Vehicle-Infrastructure Integration, and Smart Roadside programs, as well as private sector deployments of freight traveler information, load matching, and dynamic routing applications, will all influence the development of FRATIS.

Technologies and programs related strictly to commercial vehicle enforcement have been omitted from this report, as those activities are covered separately under the U.S. DOT Smart Roadside program.

In this report, "freight" refers to the entire supply chain, including carriers, receivers, shippers, and consignees. This is important in considering the full stakeholder group involved in freight transportation, which may have different information needs. However as a practical matter the most frequent users of freight traveler information are carriers.

The remainder of this report is organized as follows:

- **Section 2.0: Summary** is a high-level summary of the projects, programs, and commercial technologies profiled in this assessment.
- **Section 3.0: Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials** summarizes the state of the practice in real-time traveler information for freight users. This includes as currently deployed systems as the Cross-town Improvement Project in Kansas City, Electronic Freight

Management, and the New York State Commercial Vehicle-Infrastructure Integration work. It also includes summaries of other projects that are not necessarily focused on freight ATIS but have ATIS components such as the ongoing EnableATIS initiative. Since there is only one freight-oriented weather data program, it also is included here.

- **Section 4.0: Planning, Dynamic, and Regulatory Route Guidance** assesses current efforts in the emerging area of dynamic routing for trucks. This includes private sector routing and fleet management solutions, as well as new routing applications that have emerged in the marketplace. Non-freight dynamic routing applications also are discussed, with differences between these systems and those required for large freight vehicles noted where applicable. Finally, automated routing, permitting, and concepts for dynamic rerouting of oversize/overweight trucks is discussed.
- **Section 5.0: Terminal Queue Status (Including Video)** describes the state of the practice in truck queue detection systems and video feeds.
- **Section 6.0: Appointment Status** describes current systems for balancing capacity at intermodal terminals with truck appointment scheduling.
- **Section 7.0: Public Sector Data Output – Performance Measures** summarizes the use of truck GPS data from third-party vendors to produce freight performance metrics, including truck speeds on important highway links, travel time between key points, and points of heavy truck congestion. This includes the use of data scrubbing techniques to provide anonymity to data owners.
- **Section 8.0: Container Load Matching** summarizes private developments in the realm of bobtail reduction, including existing load matching web sites and software packages designed to optimize drayage resource allocation.
- **Section 9.0: Transformative Goals and Performance Measures for FRATIS** describes the detailed goals, performance measures, and targets for FRATIS; based on the results of this research and other relevant documents and experience.
- **Appendix A** contains summary information about projects and research that have been superseded by more recent efforts. It also contains recent advances in freight traveler information from the Euro Zone countries.

The report includes prior and current research as well as discussion of real-world projects in each area.

2.0 Summary

This section briefly summarizes the projects, programs, and commercial products discussed in this assessment. Each program, project, or product was assessed for strengths and weaknesses, and then for its overall implications for and applicability to FRATIS. This assessment was based on prior direct involvement with a given program, Internet research, related project work, and the collective professional judgment of the consultant team.

Table 2-1 summarizes the results of this process. Technologies are broken down by functional areas which, upon preliminary assessment, can be thought of as broad FRATIS functionalities. Where multiple technologies or programs lead to the same general conclusion, implications for FRATIS of those projects or technologies are grouped together.

For additional details regarding projects, technologies, or products, readers should consult corresponding sections of the document.

Table 2-1. Strengths and Weaknesses of Technologies and Relationship to FRATIS

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials				
EnableATIS	Operational concept for future travel information program environment	Will provide program environment for future travel information applications	Application developers have been somewhat absent from the stakeholder meetings	Government role in general ATIS should focus on facilitation
Electronic Freight Management	Web technology to improve data sharing in the supply chain for shipment visibility	Multiple deployments have demonstrated ability to integrate data from multiple sources into actionable intelligence	Resource constraints make it hard to secure cooperation from all supply chain partners	Need to understand motivations and constraints to full participation by all supply chain partners
C-TIP	Technology to improve efficiency of intermodal transfers between railroads in Kansas City Includes traveler information, dynamic routing, and drayage optimization	C-TIP OSAP achieved bobtail reductions with deployment of enabled smartphones	Developments in the private marketplace occurred faster than systems engineering approach could adapt	FRATIS should leverage existing private sector applications in the development process
Connected Vehicle Research	Multimodal research into wireless communications for ITS	New York CVII work first to use DSRC in a commercial environment	Regulatory uncertainty regarding new vehicle mandates for V2I and V2V safety applications	Future applications could include geo-based routing for 5.9 GHz DSRC and smartphones
SmartPark	ITS demonstration for providing parking information in real-time to truck drivers	Proven concept for collecting occupancy and availability data; testing currently exploring different technologies to disseminate data	N/A; testing is ongoing	Monitor developments in this realm for possible inclusion in FRATIS applications
I-5 Smart Truck Parking	ITS demonstration for providing parking information in real-time to truck drivers	Potentially scalable concept with goal of commercial viability	N/A; testing is ongoing	Potential data resource and model for a value-added FRATIS application

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials (continued)				
ATRI Critical Weather Thresholds for Trucks	Define truck-specific weather thresholds and field an information system providing real-time updates to truck drivers when thresholds are crossed	New research into real-time weather data capture and dissemination to truck drivers	N/A; research is ongoing	Coordinate with ATRI truck weather thresholds work
State and Local Traveler Information Systems with Freight Components	State and regional ITS resources with freight-specific information	Provides freight information customized by state/region	General lack of such systems in most parts of the country	There could be an unmet need for freight-specific travel information tailored to individual corridors or regions
Maryland Emergency Truck Parking Portal	Maps and directions to emergency truck parking during severe snow storms via Web and smartphone	Smartphone application shows truckers' location in relation to nearest emergency parking	Does not include information about parking availability	New use of smartphone technology to disseminate truck parking information
HoldingPen.com Private Truck Parking ITS	Private sector ITS solution uses license plate recognition to manage truck parking in the Inland Empire warehousing sector	Truckers only pay for parking they use	Only deployed in Inland Empire, California	There may not be very many markets where this would provide a sustainable business model
TransCore Real-Time Onboard Vehicle Reporting	GPS/GSM system for fleet management	Tracks key safety indicators wirelessly without creating distracted driving issues	N/A	Could provide a real-time fleet communications platform without causing distracted driving
Planning, Dynamic, and Regulatory Route Guidance				
TomTom Truck-Specific Navigation	Commercial truck navigation and proprietary routing	Incorporates truck-specific attributes in the roadway network	Commercial vehicle data are not yet broken out separately in link flow and other reports	Potential opportunity to offer truck restricted routing through a state-of-the-practice dynamic route guidance engine
INRIX 3rd Generation Routing	Proprietary routing engine	"Time-intelligent" routing goes beyond traffic avoidance capability	Not customized specifically for truck movement	

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Planning, Dynamic, and Regulatory Route Guidance (continued)				
NAVTEQ Truck Routing	Commercial truck navigation and routing	Includes height, weight, and other restrictions in routing	Comprehensiveness of truck route coverage unclear	Potential opportunity to offer truck restricted routing through a state-of-the-practice dynamic route guidance engine
Google Maps Navigation	Free routing and traffic application for Android	Free; can recognize voice commands for directions	Not freight-specific	
Qualcomm In-Cab Navigation	Truck-oriented in-cab navigation	Specifically targeted towards trucking industry	Dynamic routing feature is "near real-time"	Potential opportunity for FRATIS to develop a truly dynamic, real-time truck routing capability
Rand McNally IntelliRoute	Routing software for fleet managers, in-cab GPS devices for trucks	"Traffic predictor" incorporates historical traffic info into route recommendations	N/A	
Teletrac	GPS tracking and fleet management software and hardware developer	"Nearest vehicle" locates truck closest to a given move	Requires purchase of Teletrac hardware	
Garmin	In-cab GPS devices for trucks	In-cab GPS units designed for truckers	Not the firm's core business area	
PC*Miler	Commercial software package for truck routing	Users can enter unlimited number of stops and optimize routing by different parameters	N/A	
Automated OS/OW Permitting and Routing	Commercial software for OS/OW route generation and permitting activities	Can provide carrier self-service capability for routine OS/OW loads	Network data typically cannot support truly dynamic routing of OS/OW trucks	Truly dynamic routing of these loads would probably have to be built from the ground up
Dynamic OS/OW Routing	Concepts for automated OS/OW routing	Theoretical ability to have truly dynamic OS/OW routing	Data timeliness/accuracy Resource constraints – the most advanced systems require nearly constant data updates	Linking legacy permitting systems to existing state 511 systems has potential but relies on timely/accurate data and sufficient staff resources Dynamic routing of overdimensional loads is complicated by regulatory requirements

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Terminal Queue Status (Including Video)				
WSDOT Intermodal Data Linkages Freight ITS Study	Deployment of congestion management systems at Ports of Tacoma and Seattle	Proved concept of truck-specific ITS Terminal queue video feeds were popular despite limited size of user group	Testing of the queue detection system was hampered by completion of an interchange upgrade	Integrating freight traveler information with existing travel information systems has some promise Video feeds are a popular source of queue information for the intermodal trucking community
Seattletrucker.com	Private web site with links to port traffic cameras in Seattle and Los Angeles	Aggregates traffic cameras into one place	Only covers Seattle and Los Angeles	Potentially scalable concept for FRATIS
Sensys Networks Queue Detection Systems	Wireless, in-ground sensors for traffic queue, volume, and speed detection	Easy to install Utilizes low-cost wireless technology	N/A	Could be used for wireless queue detection at terminal gates
Freeahead Bluetooth Queuing and Vehicle Detection System	Bluetooth devices detect equipped vehicles and calculate actual travel times and current wait times from back of queue	Scalable, low-cost solution Large and growing penetration of Bluetooth-equipped vehicles	Privacy concerns	Successfully tested at international border crossings; could potentially be used for terminal queue detection
Traficon Traffic Video Detection	Video image processors develop queue metrics based on camera feeds	Customizable zones for queue monitoring	N/A	Could be used in conjunction with existing terminal web cams
Appointment Status				
Advent Port Community System	Modular port and terminal management system. One of the modules supports truck appointment systems. Others support drayage truck registries, truck tracking, community portals, clean truck programs, and traffic mitigation programs.	Customizable appointment system module can allocate time slots by time of day, day of week, and transaction type Can interface with terminal operating system for increased efficiencies	N/A	Potential for integration with a FRATIS drayage optimization function, which could achieve additional queue reduction and air quality benefits Would require marine terminal operator and port participation

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Appointment Status (continued)				
Telvent Management and Information System for Ports	Port management system focusing on coordination among port agents, entities, and port services on ships to manage ship arrival, unloading/loading, and departure	Coordinates portwide activities among many different actors Integrates with existing port systems Real-time system monitoring	Not specifically designed as a terminal appointment system	Potentially could be used to support an appointment system with vessel arrival data
Port Metro Vancouver Container Terminal Scheduling System	Terminal reservation system at Port Metro Vancouver (British Columbia)	Mandatory for imports, which increases utilization of the system	Cannot accommodate two-way container movements in one window	Make sure that appointment systems work with drayage optimization strategies
Southampton, United Kingdom Truck Appointment System	Terminal reservation system at the Port of Southampton (United Kingdom)	Provides truckers and dispatchers the ability to change appointments based on changing customer needs	Financial impacts on drayage firms of no-show penalties and booking fees No reciprocal penalties for terminals	Portwide systems require extensive outreach to the port trucking community
Long Beach Total Terminals International Appointment System	Terminal reservation system at Total Terminals International, Port of Long Beach	Mandatory for imports and exports, which increases utilization of the system	N/A	Study best practices in appointment systems to find out what characterizes successful ones
Sydney Ports Vehicle Booking System	Terminal reservation system at Port Botany, Sydney, Australia	Reciprocal financial penalties for trucker and terminal noncompliance Integrated into comprehensive improvement package that includes peak-period charging Independent third party monitoring	N/A	Comprehensive queue management and terminal appointment strategies may achieve the greatest benefits

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Public Sector Data Output – Performance Measures				
Private Sector Truck Fleet GPS Data Sharing	Use of private truck GPS data for modeling and performance measurement	Rich source of truck movement data for performance monitoring and modeling	Privacy issues	Ensure appropriate confidentiality provisions in data sharing agreements with private sector
Iteris iPerform Performance Measurement System	Real-time performance monitoring application for public sector transportation agencies	Aggregates and analyzes multiple sources of real-time system performance data	Ongoing cost to maintain	May be a useful resource for the public sector performance monitoring function
Container Load Matching				
Profit Tools	Dispatch and billing management software for smaller trucking firms	Track and Trace module automatically pulls container data from rail web sites	N/A	Software solutions for this problem exist but not all operators can afford sophisticated IT systems
Trinium	Enterprise software for mid- to large-size trucking firms	Availability Manager similar to Profit Tools Track and Trace	N/A	
RMI Vantage	Intermodal terminal business intelligence tool	Real-time monitoring with graphical dashboards	N/A	
Loadmatch.com/ Drayage.com	Loadmatch.com publishes empty container data posted by users for potential reloading Drayage.com is a directory listing of draymen who can outgate containers from a terminal	Can push container availability updates on to clients' computer systems such as Profit Tools	N/A	There are practical and institutional obstacles to matching intermodal containers, not all of which are under the control of draymen
NCFRP Truck Drayage Productivity Guide	Guidebook for planners interested in improving the efficiency of port dray operations	Encapsulates all of the major causes of dray inefficiency in one report	N/A	There may be opportunities to reduce dry runs and other unproductive activity through better information sharing but this would require cooperation from multiple stakeholders

3.0 Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials

Advanced Traveler Information Systems (ATIS) have been at the forefront of Intelligent Transportation Systems (ITS) research and system deployment for more than a decade.[2] Accordingly, much emphasis has been placed on obtaining, integrating, and disseminating real-time travel data such as freeway and arterial link speeds/congestion, incident information, and weather updates. Advances in the field have manifested themselves as sophisticated Traffic Management Centers and regional governmental partnerships delivering such information via 511 web sites, and (more recently) smartphones. However, to date relatively few of these efforts have been focused on freight, which has very different operational characteristics (and thus different information needs) than passenger travel.

Nonetheless, U.S. DOT has sponsored research into freight-oriented ATIS and Intelligent Transportation Systems (ITS), and successful national and regional programs have been developed in areas, including truck parking and freight information exchange. There also have been private initiatives, as well as state and local ATIS providing freight-specific information. In general, this work can be categorized as follows:

- **Freight information exchange –** Enabling cooperative platforms for truck dispatch and other freight operations, or mining data from multiple sources to improve supply chain visibility;
- **Vehicle-to-vehicle and vehicle-to-infrastructure communications –** New technologies that enable trucks to communicate with other vehicles and with the roadside, primarily for safety applications;
- **Parking information –** Gathering, analyzing, and disseminating information about truck parking availability to drivers;
- **Weather information –** Collection and dissemination of freight-specific weather hazard information to truckers and dispatchers; and
- **Enforcement –** Automated credentialing and enforcement of commercial vehicle regulations.

Commercial vehicle enforcement technologies are not directly related to FRATIS and are being deployed through the ongoing Smart Roadside project. Therefore these applications are not included

[2] ITS is a branch of transportation engineering which seeks to improve safety and mobility through the integration of advanced communications technologies into the transportation infrastructure and in vehicles. ATIS is a subset of ITS focusing on the dissemination of real-time travel information to transportation system users.

here. For each of the other categories, one or two recent projects are summarized to assess the state of the practice. Additional projects or research in each area are provided in the Appendix.

Table 3-1 summarizes the state of the practice in this area. Most deployed systems revolve around safety (e.g., vehicles communicating wirelessly with each other and the roadside), intermodal asset tracking and shipment visibility, and the provision of basic traveler information, some of which is freight-related. Benefits are often measured in terms of improved safety and emissions reduction. The most recent applications have involved using web technology to integrate supply chain data from several sources into actionable business intelligence (Electronic Freight Management), and rationalizing cross-town intermodal handoffs through collaborative dispatch, traffic monitoring, and alternate/dynamic routing (Cross-town Improvement Project). There also have been interesting deployments from the private sector in this field, such as a company in California's Inland Empire that is developing a pay-as-you-go truck parking concept for the warehousing and distribution industry in that region. In the realm of freight-oriented weather information, only one project stands out for being specifically targeted towards trucks: The ATRI Critical Weather Thresholds for Trucks project will seek to develop and test a beta system to provide real-time weather updates to truckers whenever certain predefined thresholds are crossed. (It is worth noting here that several of the custom truck routing systems profiled in Section 0 can provide warnings regarding truck weather hazards such as high cross winds.)

The following sections describe these projects in more detail. For additional information on particular projects or studies, readers are encouraged to consult the reference documents listed at the end of each project profile.

Table 3-1. Assessment of Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials

Technology/ Program/Project	Functional Area(s)	Description	Scope and Timeframe[a]	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
EnableATIS	Guidance/planning project for new mobility applications	Operational concept for future travel information program environment	Medium 2011-Present	Will identify program vision and application opportunities	N/A	"Business-as-usual" approaches to ATIS Data sharing obstacles Funding limitations	Government role in general ATIS should focus on facilitation
Electronic Freight Management	Freight information exchange	Web technology to improve data sharing in the supply chain for shipment visibility	Large 2007-Present	Shipment visibility Improved productivity	Vary by deployment but tend to revolve around labor/freight productivity, improved data quality, and better visibility	Data privacy in the Columbus test Logistics service providers for Kansas City partner were reluctant to participate since they saw little benefit Disruption in Kansas City test due to partner migrating to new ERP system	Supply chain partners need to see a benefit to these technologies, or be compensated for technical services outlays
C-TIP	Freight information exchange	Technology to improve efficiency of intermodal transfers between railroads in Kansas City Includes traveler information, dynamic routing, and drayage optimization	Large 2004-2011	Successful "proof-of-concept" of en route truck redirection, collaborative truck dispatch platform	Time savings Route compliance Emissions Fuel savings	Kansas City was a limited test bed Route definition issues on some lanes prevented collection of valid travel time information Railroads did not participate, preventing measurement of actual bobtail reduction	There is scope for time savings and emissions reductions through dynamic routing for trucks Benefits would be greater in a larger intermodal market Industry may lack the collaborative mentality required to make a cooperative dispatch platform work Drayage optimization efforts should focus on improving the dispatch operation and providing better data to draymen
Connected Vehicle Research	V2V/V2I/VII communications	Multimodal research into wireless communications for ITS	Large Ongoing program	Vary – Mainly safety and environmental	Crash reduction Emissions	Policy uncertainty (NHTSA may make technologies mandatory on new vehicles)	NYSDOT CVII project demonstrated DSRC for low-latency, secure communications on freight vehicles for safety and credentialing
SmartPark	Truck parking	ITS demonstration for providing parking information in real-time to truck drivers	Large 2007-Present	Would divert trucks from filled to empty spaces Would help truckers manage fatigue	Improved safety Better utilization of truck parking facilities	N/A – Tests and evaluation are ongoing	N/A
I-5 Smart Truck Parking	Truck parking	ITS demonstration for providing parking information in real-time to truck drivers	Large Testing is ongoing	Would divert trucks from filled to empty spaces Would help truckers manage fatigue	Improved safety Better utilization of truck parking facilities Reduced emissions Improved driver productivity	Working across public-private-academic institutional boundaries	Collaborative approach may stimulate development of a private service that addresses a public need
ATRI Critical Weather Thresholds for Trucks	Weather data for truckers	Define truck-specific weather thresholds and field an information system providing real-time updates to truck drivers when thresholds are crossed	Small 2011-Present	Improved weather info can mitigate crashes and improve mobility	Crash reduction Reduced freight delays from weather events	None identified	None to date – research is ongoing
State and Local Traveler Information Systems with Freight Components	State and local traveler information	Washington State and the I-5 Corridor Travel Information site are the leaders in this area	Varies by location Ongoing programs	Freight-specific data for improved operational efficiency	Better data dissemination for freight travelers on a major goods movement corridor	Nationally, these systems appear to be quite limited and only exist for a few corridors	N/A

Technology/ Program/Project	Functional Area(s)	Description	Scope and Timeframe[a]	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
Maryland Emergency Truck Parking Portal	State and local traveler information	Maps and directions to emergency truck parking during severe snow storms via Web and smartphone	N/A Implemented 2011	Improves safety and roadway clearance operations by encouraging truckers to find safe parking off of the roadside	Improved safety Improved snow clearance	N/A – Pilot program is ongoing	N/A
HoldingPen.com Private Truck Parking ITS	Truck parking	Private sector ITS solution uses license plate recognition to manage truck parking in the Inland Empire warehousing sector	N/A	Obviates need for logistics companies to lease yards Firms only pay for parking they use	Reduced operating expenses Reduced delays and impounds	N/A	N/A
TransCore Real-Time Onboard Vehicle Reporting	On-board communications	GPS/GSM system for fleet management	N/A	Safety, environmental	Fuel savings GHG reduction Accident reduction	N/A	N/A

[a] Small – <$250,000; Medium – $250,000 to $1 million; Large – >$1 million.

3.1 U.S. DOT Research Efforts and Projects

U.S. DOT has conducted research in freight ITS and ATIS for some time. The following projects represent ongoing efforts in the area of freight real-time information. There are now multiple program tracks which touch on this area, some directly and others tangentially. This extensive body of work is outlined below.

Future Policy Setting: EnableATIS

A current project running parallel to the FRATIS ConOps is EnableATIS. EnableATIS grew out of the FHWA ITS Program's ongoing Connected Vehicle and Dynamic Mobility Applications (DMA) work. Overall, the DMA Program seeks to expedite the development, testing, implementation, and commercialization of innovative ITS applications to maximize transportation system productivity and enhance the mobility of its users. Ideas for applications were solicited from stakeholders from all levels of government, academia, technology developers, policy and advocacy groups, the business community, and ATIS experts. Through this process, U.S. DOT received 93 ideas which were narrowed down to 30 applications, then further consolidated into seven "bundles" of applications which are targeted for development. EnableATIS is one of these bundles (as is FRATIS).

EnableATIS is unique among the identified DMAs in that it will provide a program environment for future traveler information capabilities, including transformative uses and applications, enhanced user-level decision support, and improved system management. The EnableATIS Operational Concept, which is scheduled for completion in April 2012, will outline the program vision, outline preliminary application opportunities, define the roles of Federal, agency, and other partners, and assess the market readiness of the concepts over the next 5 to 10 years.

A stakeholder workshop was held in Washington, D.C. in late October 2011 to further refine the EnableATIS vision and priorities, including group input to key industry trends and topical breakout groups. This workshop was structured to gather multimodal, multifield input on:

- What does the next generation of traveler information look like?
- How will we use it?
- What will be, or should be, different?
- Brainstorming on operational scenarios.
- Roles (Federal, state, local, and private).
- Timeframes and priorities.
- Challenges, constraints, and influences.[3]

An on-line survey was implemented concurrently to gather input from stakeholders who could not attend the workshop.

At the workshop and in the on-line surveys, it was generally agreed that the Federal role in EnableATIS should be facilitative, rather than connecting directly with end users through a system

[3] U.S. DOT, EnableATIS Vision and Operational Concept: Introductory Stakeholder Webinar, October 12, 2011.

engineered and developed by the DOT. This role could include functions like developing preferred data formats and standards, guidelines/lessons learned, providing financial seed money for demonstrations and pilot projects, and establishing a data clearinghouse that public and private actors can access. Another key role would be leveraging EnableATIS across other U.S. DOT initiatives, including applications for commercial vehicles.

Stakeholders generally felt that non-U.S. DOT agencies should focus on providing the basic traveler information they already provide (e.g., incidents, weather, and work zones) not only to travelers in their area, but also to third parties who are developing mobile or in-vehicle applications. There also was agreement that deployment and operation of ATIS and ATIS components would remain a core function of these agencies. Performance monitoring also ranked high as an emerging focus area for non-U.S. DOT agencies.

Priority roles for the private sector identified at the workshop tended to play to recognized private sector strengths in application development, research and development, and innovation. Venture capital funding also could be provided by businesses for applications with a sufficient ROI to merit such investment. The private sector also could have a key role in bridging data boundaries, by making data available outside of the coverage areas of typical DOT-operated systems and by devising ways to get around the institutional barriers that prevent many public agencies from sharing their data. In that sense, an important role for EnableATIS may be simply to support the dissemination of data from multiple providers, which then could be mined by the private sector to transform it into useful information. This dovetails with the key FRATIS concept of leveraging existing deployed systems to achieve public benefits.

Key challenges to successful implementation of EnableATIS primarily revolved around:

- Entrenched "business-as-usual" approaches to traveler information (i.e., resistance to changing current data sharing arrangements or agency roles), which may not accommodate the institutional changes that may be necessary to deploy a next-generation traveler information capability;
- Data sharing issues, both between multiple agencies and between agencies and private sector partners; and
- Funding limitations and resources to support new approaches.

Data and Communications

- Not applicable; this is a research project to develop an operational concept.

Conclusions

Key strengths, weaknesses, and implications for FRATIS of EnableATIS are summarized in the table below. (Similar tables are provided for each project or group of projects throughout this report. Strengths and weaknesses are drawn from the literature available; their implications for FRATIS represent CS' professional opinion.) EnableATIS is defining the overall data and policy environment for future DMAs, and as such the program bears careful monitoring before and during any future development of the FRATIS applications. An important conclusion from the early EnableATIS stakeholder meetings is that the Federal government role should be facilitative in nature, rather than to build a system from the ground up using government contractors. In this role the U.S. DOT would focus on developing preferred data standards and funding early stage demonstrations and test

deployments, with an eye towards making them self-sustaining over time. In this respect it will be important to engage the private sector application developers (which EnableATIS is seeking to do in early 2012), as well as potential users of FRATIS such as drivers and dispatchers (which will occur through the on-line surveys).

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
EnableATIS	Operational concept for future travel information program environment	Will provide program environment for future travel information applications	Application developers have been somewhat absent from the stakeholder meetings	Government role in general ATIS should focus on facilitation

References

U.S. DOT, *Vision and Operational Concept for Enabling Advanced Traveler Information Services: Summary of Stakeholder Feedbac*k, unpublished draft report dated November 11, 2011.

Freight Information Exchange

U.S. DOT surveys have shown that a significant proportion of supply chain delay stems from shipments awaiting the exchange of information.[4] As a result, DOT has targeted freight information exchange as an opportunity to improve the efficiency and environmental impact of goods movement through technology. Electronic Freight Management (EFM) and the Cross-town Improvement Project (C-TIP) are two recent projects in this area.

Electronic Freight Management

The Electronic Freight Management (EFM) initiative is a U.S. DOT-sponsored project that applies Web technologies to improve data and message transmissions between supply chain partners, enabling process coordination and information sharing among partners in the supply chain. The mechanism allows for all users, but especially small to medium sized and less sophisticated supply chain partners, to access the information, and makes it easier to customize the flow of information between and among partners.

The EFM framework is intended to provide a common platform for electronic communication of supply chain data over the Internet, thus ensuring that relevant data can be entered once but used many times, reducing manual effort and potential errors. The data conforms to international data standards and is intended to improve visibility of shipments. EFM software is open source, includes reusable Web services, and can be downloaded from the EFM web site for firms wishing to implement the system on their own account.

In order to promote industry adoption of EFM technologies, FHWA has sponsored several implementations, the first of which was in Columbus, OH. The CEFM (Columbus EFM) project was a

[4] Battelle, "Electronic Freight Management," presentation given to Fort Lauderdale IFTWG meeting, November 16, 2008.

successful 2007 deployment test which implemented web services and other components to support an existing international import truck-air-truck supply chain maintained by Limited Brands. As shown in Table 3-2, the deployment was able to achieve substantial benefits in terms of productivity for manufacturers and freight forwarders, service quality, data availability, and data quality. These benefits translated into total savings of nearly six dollars per shipment.[5]

There were some challenges to the Columbus implementation, mainly revolving around confidentiality and the protection of partners' information systems from unauthorized access. Data security layers and the implementation of digital certificates for transactions between partners mitigated this problem. Memoranda of Understanding between the partners protected sensitive shipment data from outside access.

Following the completion of the CEFM test, a case study was conducted in Kansas City, Missouri. In contrast to the Columbus test, the Kansas City case study was primarily driven by the private sector supply chain partner, with U.S. DOT involvement focusing on identifying case study participants and providing the EFM package for their use. The goal was to promote further adoption of EFM technologies with a reduced government role.

[5] Batelle and SAIC, "Electronic Freight Management," presentation given to Fort Lauderdale IFTWG, November 16, 2008.

Table 3-2. Benefits of Columbus EFM Deployment

Metrics	Quantitative	Qualitative
Productivity (Manual Data entry)	75% reduction in manual data entry for mfg 65% reduction in manual data entry for forwarder in Hong Kong 50% reduction in manual data entry for forwarder in Columbus	Fewer data entry errors Fewer work stops to research missing/ incorrect data Near real-time shipment status
Service Quality (Automated Status Data)	$11/day saved monitoring priority shipments 18% improvement in weekly shipments processed by the Customs Broker	Earlier automated and on-demand access to downstream data Quicker response to shipment discrepancies Earlier processing of Customs filings
Data Availability (Automated Data Available to All Partners)	- XML message received 6-24 hours before EDI - Booking and tendering received 1-3 days sooner - In transit status received 4-6 hours sooner with no manual research required	- Improved shipment planning through partner receipt of data not previously received
Data Quality (Error Reduction)	6% reduction in errors at warehouse or $4/error Reduction of EDI errors and time to correct them; savings of $3/error 25% improvement in data accuracy	Improvement in on-time performance from fewer data errors and exception shipments

Source: U.S. DOT.

The Kansas City case study involved a small-scale deployment and short-term use of the EFM core features by DEMDACO, a Kansas City-based importer of gift and decorative items. A deployment team led by Batelle and EDS worked with DEMDACO to implement EFM functionalities in their supply chain, which originates in China and involves container transport by ocean, rail, and truck. The deployment team identified several benefit metrics prior to the test, mostly revolving around reduced shipping, labor, and regulatory compliance costs. However, it became apparent during implementation that these measures were either not applicable to DEMDACO's situation or could not be easily evaluated due to either the short implementation period (60 days) or the lack of benchmark data to facilitate a before and after comparison. DEMDACO therefore identified three other metrics where they expected to achieve measurable benefits:

- **Reduction in outbound backorders.** The firm estimated that product backorders could be reduced by 30 percent through EFM because the system would provide more accurate inventory arrival dates, which DEMDACO's Enterprise Requirements Planning (ERP) system could then use to release customer orders for picking, packing, and shipment to the customer.
- **Increase in container utilization.** DEMDACO's existing process did not provide information on container utilization until after the box had shipped, which is too late to add additional merchandise to a partially loaded container. Since EFM data includes the shipping dimensions of each item and the type of container being used, it can

calculate the container utilization for each shipment and identify opportunities to load boxes more fully prior to shipment, thereby increasing utilization. DEMDACO expected box utilization to increase by four percent using EFM.

- **Reduction in the cost of 10+2 filing.** U.S. Customs recently began requiring importers to file documentation providing the location a container was loaded as part of the customs declaration. Most ERP systems have no provision for this, which often forces importers to pay their customs brokers to research the information and provide it to CBP. EFM can capture this information from the ocean carriers and report automatically to the customs broker. DEMDACO anticipated reducing the cost of 10+2 regulatory compliance by 50 percent through EFM.[6]

Batelle used the Freight Technology Assessment Tool to evaluate the financial impacts of the Kansas City case study. Benefits were calculated under two IT scenarios: one with completely outsourced IT operations and the other with in-house IT. The results are shown in Table 3-3, which demonstrates a positive financial return under both scenarios.

Table 3-3. Financial Assessment of DEMDACO EFM Case Study

Metric	Outsourced IT	In-House IT
Internal Rate of Return	70.94%	97.64%
Payback	1.31	0.99
Discounted Payback	1.51	1.22
Benefit/Cost Ratio	2.75	3.64

Note: Assumes a discount rate of 12 percent and a project life span of 5 years.
Source: Batelle, *Kansas City EFM Deployment Case Study*, June 24, 2009.

Notwithstanding these positive results, the DEMDACO case study did run into some challenges, some anticipated but others not. For example, the short test period was not long enough to effectively demonstrate some of the expected operational benefits in a global supply chain. Moreover, DEMDACO's logistics service providers did not see a direct benefit for them in the project, and therefore had little incentive to participate except to satisfy their customer. This necessitated workarounds and additional project resources when the data provided by carriers did not meet the requirements of the project, or when carriers expected to be compensated for technical services outlays related to EFM.

Nonetheless, the Kansas City case study did demonstrate that the EFM system could collect and aggregate shipment status events from various supply chain partners and turn them into useful business information for DEMDACO. This initial success also led to a follow up case study with DEMDACO. The second case study focused on utilizing Electronic Data Interchange (EDI) to improve shipment visibility for DEMDACO through the Kansas City Trade Data Exchange (TDE), which is a public-private partnership providing a cargo, data, and risk management clearinghouse enabling multiple partners to track shipments without having to enter data multiple times or contact multiple parties. Expected benefits include:

[6] Batelle, *Kansas City EFM Deployment Case Study*, June 24, 2009.

- Better visibility of EDI messages through integration of EFM web services into the TDE and DEMDACO systems, specifically visibility into the booking process and improved data accuracy, timeliness, and completeness;
- A single access point for DEMDACO to view shipments and purchase orders;
- A reduction in redundant data entry for DEMDACO; and
- Improved labor utilization at DEMDACO from having better supply chain intelligence (for example having warehouse workers available when they are required to unload a truck, but not before).

Additional case studies were completed in 2011 with WorldWide Integrated Supply Chain Solutions (in Des Moines, Iowa) and Interdom Partners, Agmark, and Pride Logistics (in Chicago). In each case study, a web-based data exchange is developed and implemented among supply chain partners and a test is run over several months to measure the benefits associated with the test.

Data and Communications

- Internet-based supply chain management system. Client firms and their supply chain partners provide data feeds to reduce manual entry (and associated errors). Participating company gets better shipment visibility for asset allocation and business planning. Specific data flows vary by application.

Conclusions

EFM successfully built on the groundwork laid by the IFTWG Asset Tracking project. By using a standardized web-based data platform, shipment data can be entered once and propagated through the supply chain instead of having to be transcribed manually at each step. The technology can be customized to meet the needs of different firms with different supply chains. EFM also is taking the first steps towards becoming self-sustaining, with recent case studies relying more on private initiative rather than government sponsored tests. As FRATIS moves into the initial development stages, it should remain focused on leveraging private sector initiative and innovation, with an eye towards becoming self-sustaining over time and achieving near-universal adoption over time. However, the data sharing and participation difficulties sometimes encountered suggest a need to pay close attention to the motivations of all stakeholders.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Electronic Freight Management	Web technology to improve data sharing in the supply chain for shipment visibility	Multiple deployments have demonstrated ability to integrate data from multiple sources into actionable intelligence	Resource constraints make it hard to secure cooperation from all supply chain partners	Need to understand motivations and constraints to full participation by all supply chain partners

References

Batelle and SAIC, "Electronic Freight Management," presentation given to Fort Lauderdale IFTWG, November 16, 2008.

FHWA/Battelle, *Kansas City EFM Deployment Case Study*, June 24, 2009.

U.S. DOT, *Detailed Design Guide for Core Components of the Electronic Freight Management System (EFM) Package*, July 17, 2009.

SAIC, *Project Plans EFM Case Studies*, February 19, 2010.

SAIC, *Interdom Partners Electronic Freight Management Case Studies*, April 2011.

Batelle, *Kansas City EFM Deployment Case Study*, June 24, 2009.

Cross-town Improvement Project

The Cross-town Improvement Project (C-TIP) was first conceptualized in 2004 as an "intermodal move database" that would help coordinate cross-town drayage moves between rail terminals, thus helping to reduce empty moves (bobtails) as well as the noise, emissions, and congestion impacts of cross-town truck traffic. Over the years, stakeholders from the Intermodal Freight Technology Working Group (IFTWG, where the idea first originated) coalesced around a more detailed conception of C-TIP functionalities, culminating in a 2009 Concept of Operations which outlined five key elements:[7]

- **Intermodal Move Exchange (IMEX) –** An open architecture port that allows for a collaborative dispatch management model among rail lines, truckers, and facility operators.
- **Wireless Drayage Updating (WDU) –** Utilizes low-cost wireless technology as an interface between drivers and dispatchers, and between the core functions within C-TIP and its users.

[7] C-TIP includes components in all three FRATIS application bundles (Freight Real Time Traveler Information, Dynamic Route Guidance, and Drayage Optimization). All components are summarized here so the project can be discussed in one place.

- **Real-Time Traffic Monitoring (RTTM) –** Real-time monitoring and distribution of route- and location-specific travel time and congestion information and control of traffic management systems and devices.
- **Dynamic Route Guidance (DRG) –** Uses inputs from RTTM, a dedicated Geographic Information Systems (GIS) source, and specially developed simulation tools to provide truckers with real-time visual routing around congested areas.
- **Chassis Utilization Tracking (CUT) –** An application that allows for collaborative use and management of intermodal chassis among railroads and trucking companies.[8]

The C-TIP Open Source Architecture Package (C-TIP OSAP) was developed at a later stage to target drayage optimization efforts specifically towards drayage operators. This addressed the low railroad participation in the C-TIP IMEX test.

Tests of different C-TIP components were carried out in 2010 and 2011. Table 3-4 provides high-level summaries of the test results. Benefits primarily revolve around:

- **Productivity.** The C-TIP OSAP drayage optimization tests achieved measurable benefits in terms of bobtail reductions. Similarly, RTTM and DRG exhibited travel time benefits on Kansas City intermodal lanes, while the IMEX simulations revealed potential for significant drayage load matching thus reducing bobtail trips especially in Chicago;
- **Emissions reduction.** The evaluators calculated emissions savings using EPA emissions factors for dray trucks, average speeds, and known or average trip distances. RTTM and DRG, for example, achieved aggregate emissions reductions (all measured pollutants) of 10 percent and 6 percent respectively.
- **Fuel savings.** Fuel savings benefits were calculated using average dray tractor-trailer miles per gallon figures combined with known or average distances between terminals or delivery points.

[8] Intermodal Freight Technology Working Group, *Cross-Town Improvement Project Concept of Operations: 2009 Update*, July 2009.

Table 3-4. Summary of C-TIP Test Results

Test	Location	Dates of Test	Description of Test	Test Results					Report Section
				C-TIP Module Deployed	Actual or Simulated	Productivity Results	Emission Reductions[b]	Fuel Savings	
IXT Drayage Optimization	Kansas City, Missouri	6/28/2011 8/31/2011	Deployment of iPhones to optimize drayage moves	IMEX WDU	Actual	137 Bobtails Eliminated	1,721,823 grams	8%	Section 3.1
Pride Logistics Drayage Optimization[a]	Chicago, Illinois	8/1/2011 9/30/2011	Deployment of automated dispatching system with Android smartphones to optimize drayage moves	IMEX	Actual	30 Bobtails Eliminated	2,296,502 grams	52%	Section 3.2
Dynamic Route Guidance	Kansas City, Missouri	12/1/2010 4/30/2011	Deployment of RTTM/DRG-enabled iPhones	IMEX WDU RTTM DRG	Actual	21% Travel Time Improvement	109,822 grams	10%	Section 2.2
Real-Time Traffic Monitoring	Kansas City, Missouri	12/1/2010 4/30/2011	Deployment of RTTM/DRG-enabled iPhones	IMEX RTTM	Actual	19% Travel Time Improvement	54,300 grams	6%	Section 2.1
Kansas City IMEX Simulation	Kansas City, Missouri	10/1/2010 1/31/2011	Simulated matching cross-town railroad container moves	IMEX	Simulated	135 Empty Trips Eliminated	2,570,597 grams	8%	Section 2.3
Chicago IMEX Simulation	Chicago, Illinois	1/1/2011 4/30/2011	Simulated matching cross-town railroad container moves	IMEX	Simulated[a]	1,654 Empty Trips Eliminated	110,231,008 grams	17%	Section 2.3

Source: Cross-town Improvement Project Evaluation, 2012.

Note: IMEX: Intermodal Move Exchange.
WDU: Wireless Drayage Updating.
RTTM: Real-Time Traffic Monitoring.
DRG: Dynamic Route Guidance.

[a] Results assume three-hour delivery window.

[b] Includes carbon monoxide, oxides of nitrogen, volatile organic compounds, carbon dioxide equivalents (greenhouse gases), particulate matter, and fine particulates.

Overall, these results are positive, but C-TIP encountered some significant obstacles during the testing phase. For instance, as mentioned previously the railroads had limited participation in the IMEX test, thus necessitating a simulation rather than an operational test. Similarly, comparatively few smartphones were deployed in the operational test, leading to overall modest measured benefits (although as the Chicago tests show, scaling the system up could provide substantial benefits). There were some issues with primary and alternate routing definitions within RTTM and DRG which led to no alternate routes being offered on some lanes during the test. On a broader level, the low participation in the IMEX piece suggests that the intermodal industry may lack the collaborative mentality needed to make a cooperative dispatch platform work. One potential reason for these limitations was the use of a government systems engineering approach for the project. While technically sound, this approach took several years to implement. During this time, the intermodal industry changed some of its operational practices by moving more cross-towns via direct rail-to-rail interchange rather than drayage truck, and developments in the private traffic information and navigation marketplace occurred much faster than the C-TIP development process could adapt. These factors (along with weak economic conditions) conspired to limit participation in the program.

Data and Communications

- IMEX server processes daily cross-town move requirements to generate optimal load plan; railroads and trucking companies can view daily plan and accept or reject moves. C-TIP OSAP relays driver location and container availability data through IMEX server for more efficient load planning and asset utilization. RTTM and DRG incorporate KC Scout (regional traffic operations center) and NAVTEQ data feeds to generate route recommendations; these are relayed wirelessly to truckers through IMEX server via a smartphone interface.

Conclusions

C-TIP was an ambitious program in that it included components from all three FRATIS application bundles – freight real-time traveler information, dynamic route guidance, and drayage optimization. C-TIP proved the concept of bobtail reduction through cooperative dispatch and successfully demonstrated dynamic routing for trucks. However, much of the private sector partnership momentum associated with C-TIP waned during the five-year system development process. At the same time, advances in location-based services were being made at a much faster pace, and the national economic downturn and changing railroad operational practices resulted in far fewer moves that could benefit from C-TIP than originally hoped. This suggests that it will be important to leverage existing deployed systems and the shorter product life cycle found in the private marketplace during development of the FRATIS application bundles.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
C-TIP	Technology to improve efficiency of intermodal transfers between railroads in Kansas City	C-TIP OSAP achieved bobtail reductions with deployment of enabled smartphones	Developments in the private marketplace occurred faster than systems engineering approach could adapt	FRATIS should leverage existing private sector applications in the development process

References

Intermodal Freight Technology Working Group, *Cross-town Improvement Project Concept of Operations – 2009 Update*, July 2009, available at http://www.ctip-us.com/ctip_files/Concept%20of%20Operations%20Report%20-%20July%202009.pdf.

U.S. DOT, *Cross-town Improvement Project Evaluation Final Report*, February 2012.

Vehicle to Infrastructure and Vehicle to Vehicle Communications

Connected Vehicle (previously Intellidrive) research is a multimodal initiative that aims to enable safe, interoperable networked wireless communications among vehicles, the infrastructure, and passengers' personal communications devices. Connected Vehicle research is being sponsored by U.S. DOT to leverage the potentially transformative capabilities of wireless technology to make surface transportation safer, smarter, and greener. Connected vehicle technologies are envisioned to ultimately encompass safety applications, mobility applications, and environmental applications.

The program encompasses all of the DOT's efforts related to Vehicle to Vehicle communications (V2V), Vehicle to Infrastructure communications (V2I), and Vehicle-Infrastructure Integration (VII). Much of this work revolves around safety, including a project to develop Retrofit Safety Devices (RSD) with V2V applications and truck driver clinics which include two trucks equipped with wireless crash warning devices. The findings of this work will likely influence a potential Commercial Vehicle Operations (CVO) regulatory decision to require some sort of wireless safety technology on new trucks to support V2V and/or V2I safety applications.

Additional tracks are investigating real-time data sources and potential uses for them (Real-Time Data Capture and Management), dynamic mobility applications development (including FRATIS DMAs), road weather data, and the use of real-time data to facilitate environmentally friendly decision-making by transportation system users and operators.

The U.S. Department of Transportation (DOT) is committed to the use of Dedicated Short Range Communications (DSRC) technologies for Connected Vehicle active safety applications. This includes both vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) active safety applications. DOT intends to explore the full range of wireless technologies (including DSRC as well as other options) for their applicability to other (non-active) safety, mobility, and environmental applications.

The Connected Vehicle Core Systems Engineering project provides updated baseline documentation for the connected vehicle technology platform.[9] This work refined the existing ConOps, system

[9] http://www.its.dot.gov/research/systems_engineering.htm.

architecture, user requirements, and critical deployment risks. The Connected Vehicle Core System will support safety, mobility, and sustainability applications for all modes, including trucks. The Core System is planning anonymity into the data exchange process to achieve the appropriate balance between privacy and security/safety.

Sample Connected Vehicle Freight Project: I-95 Corridor Coalition/NYSDOT Commercial Vehicle Infrastructure Integration

Connected Vehicle is not a specific program; rather it is a collection of initiatives designed to explore promising wireless technologies for transportation operations and ITS. As a specific example of relevant Connected Vehicle research, the New York State DOT Commercial Vehicle Infrastructure Integration (CVII) project is described here. Under this project, which is being funded by the I-95 Corridor Coalition and led by the New York State Department of Transportation, 5.9 GHz Dedicated Short Range Communications (DSRC) is being utilized to enable low-latent, secure communication between commercial vehicles and other vehicles and between commercial vehicles and infrastructure components. The project is led by an industry consortium headed by Volvo and supported by Cambridge Systematics and others. The purpose of the CVII project is to design, test, and demonstrate various applications that leverage the 5.9 GHz link, using appropriate IntelliDrive-supported protocols and the Volvo Connected Truck platform.

DSRC is well-suited for certain applications due to its primary characteristics:

- DSRC is licensed. In 2004, the FCC allocated 75 MHz to the DSRC frequency band.
- Security is not an afterthought. The IEEE 1609.2 and 1609.11 standards are well integrated into the DSRC communications stack and provide secure mechanisms to authenticate the sender of a message and also to enable secure transactions (e.g., tolling).
- It supports quick exchanges of data while vehicles are moving at high speeds. DSRC units utilize Wave Short Message Protocol (WSMP) to enable vehicles moving towards each other at highway speeds to exchange short, safety critical messages.
- Safety critical messages have the highest priority. Connected Vehicles utilizing DSRC separate safety critical messages onto specific channels and also include message prioritization to ensure the most critical messages are sent and received first.
- Communications are interoperable. DSRC utilizes IEEE 802.11p, IEEE 1609, and SAE J2735 standards to ensure interoperability among devices.

Past programs that utilized DSRC primarily involved passenger vehicles. CVII was the first project to utilize DSRC in a commercial vehicle environment. The CVII project has been performed in two primary phases:

- Phase 1:
  - Traveler Information/Probe Data: Establish baseline functionality for DSRC in a commercial vehicle, extending what was done in the VII Proof-of-Concept to add focus on traveler information that is useful to commercial vehicle operators while minimizing driver distraction.

- Driver Credential Verification: Interact with the driver and Roadside Equipment (RSE)/ Back Office Applications to verify that a driver's credentials are valid and up-to-date. If the driver's credentials do not check out, they cannot start the truck.
- Wireless Roadside Inspection: Gather vehicle data and driver data to exchange with the roadside infrastructure to perform quick but thorough safety checks of commercial vehicles. Vehicles that check out can bypass the station, others must pull in.
- Commercial Vehicle/Maintenance Vehicle Interaction: Maintenance Vehicles (e.g., snow plows) that are equipped with DSRC can send out a Roadside Alert/Emergency Vehicle Alert to inform commercial vehicle operators of an upcoming hazard. This could result from a snow plow in low-visibility situations or a roadside construction crew.
- Outfit New York Maintenance Vehicles with DSRC On-board Equipment

- Phase 2:
  - V2V Safety Applications: Commercial Vehicle and light duty vehicles exchange the SAE J2735 Basic Safety Message at 10 Hz to enable applications such as blind spot warnings, hard braking events, tailgate warnings, unsafe-to-merge, and unsafe-to-pass; and
  - Railroad grade crossing warnings: DSRC equipped Railroad grade crossings warn commercial vehicle drivers of approaching trains.

Upcoming activities include the development of interoperable compliance screening between existing mainline screening systems (915 MHz) and trucks using 5.9 GHz. Future applications include development of real-time geo-based routing applications for 5.9 GHz DSRC and smartphones.

Data and Communications

- DSRC transponder in truck communicates with roadside infrastructure for inspections, credentialing, and interaction with snowplows/maintenance vehicles. Commercial and light vehicles exchange safety messages, including blind spot warnings, hard braking, etc., to improve safety.

Conclusions

Connected Vehicle research has laid much of the groundwork for enabling wireless V2V and V2I communications. The New York CVII project took this a step further by creating the first demonstration in a commercial trucking environment. This technology could enable real-time truck routing for FRATIS using the 5.9 GHz band and/or routing capabilities for in-cab smartphones.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Connected Vehicle Research	Multimodal research into wireless communications for ITS	New York CVII work first to use DSRC in a commercial environment	Regulatory uncertainty regarding new vehicle mandates for V2I and V2V safety applications	Future applications could include geo-based routing for 5.9 GHz DSRC and smartphones

References

National Highway Traffic Safety Administration, *Frequency of Target Crashes for IntelliDrive Safety Systems*, October 2010, available at http://www.nhtsa.gov/DOT/NHTSA/NVS/Crash%20Avoidance/Technical%20Publications/2010/811381.pdf.
U.S. DOT Intelligent Transportation Systems Joint Program Office, "Connected Vehicle Technology," available at http://www.its.dot.gov/research/systems_engineering.htm.

I-95 Corridor Coalition, *Commercial Vehicle Infrastructure Integration*, available at http://www.i95coalition.org/i95/Portals/0/Public_Files/CVII/CVII%20-%20TrifoldBoard%20Oct%202010.pdf.

Truck Parking Initiatives

The lack of adequate information on truck parking availability has been a topic of research for the last several years. The FHWA has found that while adequate parking capacity exists, spaces are not necessarily where the demand is.[10] Consequently, FHWA has sponsored further research in this area with a program called Smart Park. A competitive grant program was established under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) to provide funding for projects (including ITS improvements) that address truck parking shortages.

Smart Park

The mission of the Smart Park program is to reduce the number and severity of commercial motor vehicle crashes and enhance their operational efficiency through the provision of better parking availability information. Demonstration work is being undertaken in two phases:

- Phase I demonstrated a technology for collecting data on space occupancy levels at a truck parking facility and determining from the collected data how many spaces were available; and
- Phase II (which is ongoing) is demonstrating technologies for disseminating parking availability information, forecasting future availability based on historical data, and diverting truckers from occupied parking to unoccupied spaced within the same corridor or region.

Phase II of Smart Park recently began, and currently is exploring two different types of technologies:

- A Foster-Miller, Inc. test of a vehicle imaging technology-based smart-truck parking system applied to public rest stops; and
- A Vehicle Sense, Inc. test of a magnetometer technology-based smart-truck parking system applied to private truck stops.

[10] FHWA, *Study of Adequacy of Commercial Truck Parking Facilities*, March 2002.

Data and Communications

- Phase I utilized magnetometer technology to determine truck parking availability at two test sites in Massachusetts. The magnetometers detect the presence of a truck through a disturbance in the earth's magnetic field. Magnetometers are embedded in the pavement and wirelessly send data to a base station unit. A central database server collects this data from all base stations and uses an algorithm to determine truck parking availability. A "ground truth" camera also was installed to allow for manual verification of vehicle detection and classification.[11]
- Phase II would use webcams to collect real-time data on truck parking availability and communicate to truckers via radio or other communications protocol.

Conclusions

The lack of reliable, timely information about available truck parking has been noted by the research/ regulatory community and the trucking industry. Therefore SmartPark is an important first step in remedying this situation since it has proven a technical concept for collecting real-time parking space availability data and calculating from that data how many spaces are available in a location at any given moment. The next step is identifying a technology to effectively distribute this information to the intended audience. Testing currently is underway in this area and may be applicable to FRATIS application development efforts.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
SmartPark	ITS demonstration for providing parking information in real-time to truck drivers	Proven concept for collecting occupancy and availability data; testing currently exploring different technologies to disseminate data	N/A; testing is ongoing	Monitor developments in this realm for possible inclusion in FRATIS applications

References

FHWA, *Study of Adequacy of Commercial Truck Parking Facilities*, March 2002.

FMCSA, Smart Park: Real-Time Parking Information for Truckers', presentation by Jeff Secrist at the 2008 Smart Roadside Workshop, April 29, 2008, available at http://www.fmcsa.dot.gov/facts-research/presentations/smart-roadside-workshop/Secrist-SmartPark-alt.pdf.

FMCSA, *Smart Park Truck Parking Availability System: Magnetometer Technology Field Operational Test Results*, January 2011, available at http://www.fmcsa.dot.gov/facts-research/research-technology/report/SmartPark-Magnetometer.pdf.

[11] FMCSA, *Smart Park Truck Parking Availability System: Magnetometer Technology Field Operational Test Results*, January 2011.

I-5 Smart Truck Parking in California

The I-5 Smart Truck Parking project in California is developing a system to provide information on truck stop attributes, real-time/historical truck parking availability, and the ability for truckers to make reservations in advance. I-5 was selected as a test corridor because of its very high truck volumes and long corridors. The project is being carried out in three main phases:

- Phase 1 involves system engineering and initial deployments at two test bed sites, one at a logistics terminal in Lathrop, California and the other at the Flying J Travel Plaza in Lodi, California;
- Phase 2 includes expansion to six additional sites, two of which would be public and the other four private; and
- Phase 3 will consist of an evaluation of the system's performance and economic sustainability.

The overall project is being managed by Caltrans, with the systems engineering effort being led by Transportation Sustainability Research Center at the University of California at Berkeley. ParkingCarma is leading system deployment and implementation. ParkingCarma is a web service for matching people seeking parking to available spaces, in real-time. NAVTEQ supplies routing information for truckers, while data on truck stop attributes are provided by Promiles.

Sensor testing and calibration currently is ongoing at the two initial test sites. At the Lathrop site, a sensing system from a commercial vendor is being used and results were compared against counts conducted by humans using video recordings. At the Lodi site, technologies to be deployed include detection loops (in-road), RFID, still image processing, and video cameras. The sensing system will report availability of truck parking spaces in real-time while still images will be used for recalibration.

One of the key objectives of this work is to successfully demonstrate a system that can fulfill the public benefits required of the project (reduced emissions, improved public safety) while also developing a sustainable business model that can be scaled up and be successful without Federal support.

Data and Communications

- Information on truck parking availability is stored real-time in a database where it is matched with location/routing data and pushed out to drivers via multiple avenues, including phone, wireless device, web site, and on-board computers.

Conclusions

This is an interesting example of a public-private-academic partnership to address a problem with known public benefits that also has the potential for commercial, for-profit implementation. If the concept proves commercially viable, it could offer a model for potential value-added FRATIS applications which would be available on a subscription basis.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
I-5 Smart Truck Parking	ITS demonstration for providing parking information in real-time to truck drivers	Potentially scalable concept with goal of commercial viability	N/A; testing is ongoing	Potential data resource and model for a value-added FRATIS application

References

Martin, E. and Warner, R., "I-5 Smart Truck Parking in California: Public-Private Academic Collaboration to Aid Truckers in Finding Safe, Legal, and Available Parking Through ITS Technology," presentation given at TRB 91st Annual Meeting, January 24, 2012.

Gateway Cities Council of Governments, ITS Vendor Showcase 2, April 4, 2012.

Weather Information (Including Predictive)

In the United States, poor weather conditions contribute to over 1.5 million crashes per year, are the cause of about one quarter of all nonrecurring freeway delays, and add about $3.4 billion annually to the cost of moving goods.[12] The Road Weather Management Program at FHWA was therefore created to improve passenger and freight mobility and safety by providing better highway weather information. To that end, a research and development program has been established which has sponsored applied research in weather observation systems, decision support (e.g., for maintenance), and weather responsive traffic management.

To date, little of this research has focused on freight specifically. Although the weather information required by truckers is likely similar to that needed by passengers, there are some differences which primarily revolve around geographic coverage and timing of information delivery. For example, long-haul truckers would want weather information over a wide geographic area since they are going greater distances. They also probably want to know forecast weather conditions further ahead of time since their decisions points may be hundreds of miles from where they are going. They also may require weather information from remote areas that might not be readily available, and if they expect to be held up by severe weather they would probably want information on parking availability and roadside services along their route. Finally, large trucks are more impacted by high winds than passenger cars, and therefore might need information about wind conditions.

ATRI Critical Weather Thresholds for Trucks

In response to these unique needs, FHWA, in partnership with the American Transportation Research Institute (ATRI, the research arm of the American Trucking Associations), is conducting new research into a critical weather warning system for trucks. Unexpected weather delays increase trucking fuel and labor costs, and can even result in shipper contract penalties for late deliveries. This is in addition to the safety impacts of weather on trucking operations; for example, wind is increasingly being recognized as a cause of contributor to truck roll-over accidents.

[12] NTOC Talking Operations presentation, *Road Weather Management*, September 30, 2008.

In this project, ATRI will use Clarus[13] data to develop critical weather thresholds based on unique trucking industry issues and needs, and provide real-time notification to truck drivers who are nearing critical weather conditions. The notifications would be sent to truck drivers via (installed) wireless onboard communication devices that utilize GPS systems for position information. System geo-fencing would be used to relate weather conditions to discrete truck position points. Such a system would be the first such application designed specifically for the trucking industry. There are three main objectives for this work:

- Define critical weather conditions and the discrete metrics/thresholds that relate to the specific weather conditions. Examples include the point at which atmospheric and/or road surface temperatures reach 32 degrees, or the point at which wind speeds exceed a certain threshold. These metrics would be truck-specific, given the unique operational configurations and driving dynamics of large trucks.
- Develop a beta system – based on existing applications, data, and motor carrier operations – for geo-fencing both commercial vehicles and critical weather zones based on thresholds, and generating a notification to the driver when the truck approaches the weather zone. The system would primarily reside on the truck's onboard computer (OBC), thus allowing each truck to discretely act as its own weather management center (in contrast to managing thousands of trucks using a centralized backroom system). The OBC would look at weather conditions 30 to 60 miles ahead, examining conditions every 15 to 30 minutes (more frequently once a metric falls within a defined range). Weather condition data would be obtained through a *Clarus* data feed.
- Conduct a pilot project with recruited motor carriers in Minnesota to document the efficacy of the system design, and offer technical revisions as needed based on qualitative and quantitative feedback.

It is expected that the work will result in a proof-of-concept that confirms the viability of providing truckers with real-time weather notifications prior to entering the severe weather zone, thus allowing them to make alternative routing choices or take other precautions as necessary.

Data and Communications

- Truck's on-board computer would look at weather conditions in truck's path and generate driver alerts when certain thresholds are exceeded, allowing driver to choose better route or take other action.

Conclusions

Although little of the Road Weather Management program research has focused on freight, it may still have freight applications in terms of the data captured and stored. Much freight weather information is probably similar to that collected for passengers; differences mainly relate to the timing and geographic coverage of the information. ATRI is working to address truck-specific weather information needs such as high crosswinds; this work should be monitored closely for possible use in the FRATIS bundles.

[13] Clarus is a joint effort between the U.S. DOT ITS Joint Program Office and the Road Weather Management Program to develop and demonstrate an integrated surface transportation weather observation data management system.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
ATRI Critical Weather Thresholds for Trucks	Define truck-specific weather thresholds and field an information system providing real-time updates to truck drivers when thresholds are crossed	New research into real-time weather data capture and dissemination	N/A; research is ongoing	Coordinate with ATRI truck weather thresholds work

References

FHWA, *FHWA Weather Costs to Trucking – Task 2 Memorandum*, draft report submitted to FHWA October 7, 2011.

ATRI, *IntelliDrive[SM] Dynamic Mobility Application for Developing a Real-Time Weather Notification System for the Trucking Industry*, undated DMA application document, available at https://dma.noblis.org/node/94.

3.2 State and Local Traveler Information Systems Providing Freight Information

This section describes some key efforts at the state and local level to gather and distribute real-time traveler information specifically targeted towards freight users.

State and Local 511 Systems with Freight Information

Many states and localities have implemented traveler information systems (for instance, 511 web and phone services) which gather and disseminate travel time, congestion, and accident information for public use. However, only a few such systems provide information specifically targeted towards freight users. Washington State DOT, for instance, maintains an I-5 Corridor Traveler Information web site for the entire Interstate 5 corridor from San Diego to the Canadian border, a major truck freight corridor. For each of the three states in the corridor, the site contains links to truck stop locations, permitting information, and any restrictions applicable to trucks. Truckers can dial 511 to access traffic data anywhere in Washington, Oregon, or Northern California. There also are live traffic camera feeds of traffic conditions at various points along the corridor, including San Diego, Los Angeles, Redding, Portland, Seattle, and the border crossing at Blaine. For the locations in Washington and North Portland, Oregon, links are provided to real-time traffic condition maps. At international border crossings, these maps include congestion data for the Free and Secure Trade (FAST) and non-FAST truck lanes. The site also gives estimated northbound border wait times for general purpose, FAST, and non-FAST lanes.

A link from the WSDOT site takes travelers to the I-90 and I-94 travel information site, with traffic and weather info for that corridor from Washington to Wisconsin. There also are links to CVO restrictions for each state in the corridor.

The relative paucity of freight-oriented traveler information on most 511 sites suggests that much of the freight traveler information that does exist is basically an outgrowth of efforts to provide passenger travel information. This could represent an unmet need for regions with significant freight volumes.

Data and Communications

- 511 services typically utilize regional traffic operations center data (camera feeds, traffic volumes, accidents, etc.). I-5 portal includes links to state permitting agencies, web cams at key freight generators, and real-time congestion information where available. Truckers access data through the 511 site.

Conclusions

This state-of-the-practice scan found that there are relatively few state or regional ATIS providing freight-specific information. The ones that do exist are largely concentrated along the west coast, specifically Washington State and the I-5 corridor. There may therefore be an unmet need for such information tailored to individual states or regions to be delivered through existing travel information sites. The FRATIS initiative may provide a useful vehicle for delivering a more robust freight data set through existing ATIS deployments.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
State and Local Traveler Information Systems with Freight Components	State and regional ITS resources with freight-specific information	Provides freight information customized by state/ region	General lack of such systems in most parts of the country	There could be an unmet need for freight-specific travel information tailored to individual corridors or regions

References

WSDOT, "Canadian Border Traffic," available at http://www.wsdot.wa.gov/Traffic/border/.

"I-5 Corridor Traveler Information," available at http://www.wsdot.wa.gov/partners/tio/.

Maryland Emergency Truck Parking Portal

Though it is not part of the Smart Roadside core truck parking program, a recent Maryland project that disseminates truck parking information to truckers during severe winter weather provides an interesting example of real-time truck parking information. The Maryland State Highway Administration (MDSHA) recently rolled out a pilot program for emergency truck parking during severe winter weather. The program directs truckers to six select commuter park-and-ride lots where they can ride out snow storms instead of parking along highway ramps and shoulders, which can hamper snow-clearing efforts by road crews and can create a safety hazard for other motorists. The program also includes existing truck parking facilities in Maryland. Truckers can view this information in three different ways:

- An interactive map accessible through a web browser on a PC;
- A downloadable PDF map which can be printed; and
- A new smartphone application which identifies the trucker's location using the phone's internal GPS and shows nearby truck parking locations with highway exits and distance from the trucker's location.

Data and Communications

- Smartphone application identifies trucks' position relative to emergency parking during severe winter weather and informs truckers of proper exit to take.

Conclusions

The Maryland Emergency Truck Parking Portal may be the first application of its kind that leverages smartphone technology to distribute information about public truck parking locations to truck drivers. This is a potentially powerful tool for professional drivers since it can direct them to the nearest truck parking facilities during adverse weather conditions which can make it unsafe to operate a commercial vehicle. One drawback of the system is that it does not appear to offer any information about the availability of parking spaces, which could lead to truckers driving from one location to the next searching for parking, or simply reverting to parking on the side of the road. Nonetheless, this program is interesting as a new method of information delivery which could inform development of FRATIS applications. The Maryland pilot should be monitored along with the ongoing Smart Park testing to identify ways to disseminate real-time information on truck parking location and availability in order to maximize utilization of existing truck parking capacity.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Maryland Emergency Truck Parking Portal	Maps and directions to emergency truck parking during severe snow storms via Web and smartphone	Smartphone application shows truckers' location in relation to nearest emergency parking	Does not include information about parking availability	New use of smartphone technology to disseminate truck parking information

References

Truckinginfo, *Maryland Announces Additional Emergency Truck Parking During Winter Storms*, press release dated December 27, 2011, available at http://truckinginfo.com/news/news-detail.asp?news_id=75627&news_category_ id=19.

Maryland State Highway Administration, *Maryland Emergency Truck Parking Map*, available at http://roads.maryland.gov/pages/emergencytruckparking.aspx?PageId=856.

3.3 Private Sector Initiatives

In certain instances, private firms have ventured into projects providing freight ITS applications. Two recent notable private efforts in this area are described below.

HoldingPen.com Automated Truck Parking

A new state-of-the-art truck ITS parking facility has been deployed in Southern California near Fontana. This facility, operated by HoldingPen.com, serves the Inland Empire truck warehousing and distribution center trip market. It was developed in response to strict local ordinances in the region forbidding commercial vehicles from parking on the street. This is problematic for trucking firms since many manufacturers and distribution centers demand that trucks arrive within a certain narrow timeframe. Some carriers lease yards near key distribution facilities to manage the problem but this can be a costly option.

The ITS technology employed is license plate recognition. License plate data is captured by a video camera at the gate and transmitted to a server, which then exports the information to automated billing and other back office systems. In this way the parking operation can be completely automated. Truckers only pay for the parking they actually use, and HoldingPen.com offers solutions for short- and long-term parking.

Data and Communications

- License plate data is captured by video and read by specialized license plate recognition software on a server. The server is linked to back office functions like billing.

Conclusions

The HoldingPen.com system is an interesting example of a private, completely automated truck parking system. Due to the numerous warehouse and manufacturing facilities in the California Inland Empire, the firm's facilities are readily located near a major source of truck parking demand. However, it is not clear whether the market for this technology would exist outside of this area, since it appears to rely on the confluence of two factors: The presence of the nation's largest distribution complex, and strict local government regulations forbidding on-street truck parking. While it is clearly a viable market for the Inland Empire, there may not be many other places where this model would be self-sustaining in the short to medium term.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
HoldingPen.com private truck parking ITS	Private sector ITS solution uses license plate recognition to manage truck parking in the Inland Empire warehousing sector	Truckers only pay for parking they use	Only deployed in Inland Empire	There may not be very many markets where this would provide a sustainable business model

References

www.holdingpen.com.

Transcore ROVR

Transcore is an Intelligent Transportation Systems developer and manufacturer focusing on advanced traffic management systems, electronic toll collection, parking, and other transportation systems. With respect to freight, an important product from Transcore is Real-Time Onboard Vehicle Reporting (ROVR) system, which is a GPS device with GSM (global system for mobile communications) capability that provides cloud-based, real-time reporting of driver performance metrics such as rapid acceleration, hard braking, speeding, tilt/tipping, lateral acceleration, and excessive idling/CO_2 emissions.

ROVR is designed for fleet management purposes, to track driver behavior remotely with an eye towards improving safety, reducing fuel consumption, and promoting sustainability.

Data and Communications

- Device collects vehicle position, speed, acceleration, braking, idle time, and other parameters from the on-board diagnostics system and relays them to a cloud-based system for processing using GSM communications. The system analyzes the received data for driver behavior patterns and generates a "scorecard" which can be automatically e-mailed to all drivers in a company's fleet.

Conclusions

ROVR is designed for fleet management purposes, to track driver behavior remotely with an eye towards improving safety, reducing fuel consumption, and promoting sustainability. The ROVR GPS/ GSM functionality may provide a useful platform for creating a simple, in-cab message screen for drivers that could supply information without causing distracted driving issues. The devices also would be useful for dispatchers to track vehicle locations in real-time, and potentially for wireless information exchange with roadside infrastructure and other connected vehicles.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
TransCore Real-Time Onboard Vehicle Reporting	GPS/GSM system for fleet management	Tracks key safety indicators wirelessly without creating distracted driving issues	N/A	Could provide a real-time fleet communications platform without causing distracted driving

References

Gateway Cities Council of Governments, ITS Vendor Showcase 2, April 4, 2012.

4.0 Planning, Dynamic, and Regulatory Route Guidance

As the detail and timeliness of traffic data has continued to improve in recent years, it has become feasible to offer true dynamic route guidance and traffic avoidance applications. GPS units for passenger vehicles have been providing warnings of upcoming poor traffic conditions for some time. More recently, the growing market penetration of location-aware Smartphones has opened up new avenues in dynamic routing. Private data providers such as INRIX are combining data from traditional ITS with GPS probe data on phones and GPS devices to develop "time-intelligent" routing applications which constantly analyze and forecast traffic conditions during a trip. Similarly, Google now offers a navigation app for Android phones which provides real-time traffic information and trip times, and can interpret voice commands for destinations.

The state of the market for passenger dynamic routing is thus fairly advanced. Trucks, however, have differing needs, mainly related to geometric constraints and the need to ensure that any alternate routes offered are suitable for large trucks. A few firms have entered the niche market of specialized navigation aids for trucks. Qualcomm and Rand McNally, for instance, offer in-cab GPS devices with truck-specific features like truck-restricted routing, hazmat routes, mileage calculations following trucking industry standards, and routing optimization based on multiple stops. These devices can often be integrated with fleet management systems (including performance management software and asset tracking hardware) for a complete enterprise fleet management solution.

There is significantly less government involvement in the area of freight dynamic route guidance as compared with freight real-time traveler information (with the exception of C-TIP, which was described in Section 2.0). A notable exception is oversize/overweight (OS/OW) routing. This is because OS/OW routing is a legislatively mandated process which (depending on load characteristics) may require extensive public sector review prior to the issuance of a permit. Although many of the GPS and fleet management systems profiled here purport to offer OS/OW routing, it is not always clear how input data is obtained. In many cases, it is likely coming from states' permit offices, which are not always up to date themselves. The availability of timely construction information also is a key obstacle. Because of these data obstacles, a motor carrier will ordinarily have to check with their state's OS/OW permitting office even if their fleet management solution can provide a route. In any event, the level of detail of many states' geo-coded highway network data is not yet sufficient to support automated route generation.

Many states provide information about planned and active construction projects to the traveling public via multiple formats, including web 511 and mobile applications. For example, the Transportation Operations Coordinating Committee (TRANSCOM) is a multistate coalition of transportation and public safety agencies in the New York-New Jersey-Connecticut metropolitan region. The coalition was formed in 1986 to coordinate construction projects and information throughout the region, but its role later expanded to include comprehensive incident management and ITS operations. TRANSCOM provides data on the location and expected duration of construction projects, among other things. This information can be used by individuals, including truck drivers and dispatchers to

reroute on the fly. TRANSCOM also can supply a data feed which might support dynamic routing. However as noted above large trucks have many special considerations for routing that must be considered.

For OS/OW loads, the ability to reroute dynamically is normally prohibited by law. Even if it is not, the data required to do so is frequently unavailable or insufficient for the task, since oversized loads amplify the routing issues associated with large vehicles. For instance, a temporary construction project which reduces a bridge clearance by a few inches may not matter for conventional trucks, but may matter a great deal for an over height load. Since localities sometimes do not update this type of information very precisely, dynamic rerouting and route generation for OS/OW loads can become complicated.

Table 4-1 summarizes the state of the practice in freight dynamic route guidance. The following sections elaborate on these existing deployed systems.

Table 4-1. Assessment of Planning, Dynamic, and Regulatory Route Guidance Systems

Technology/ Program/ Project	Functional Area(s)	Description	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
TomTom Truck-Specific Navigation	Dynamic routing, fleet management	Commercial truck navigation and proprietary routing	Incorporates truck-specific attributes in the roadway network; real-time truck status updating	Time savings Fuel savings Dispatch efficiency	Commercial vehicle data are not yet broken out separately in link flow and other reports	TBD – Potential for FRATIS testing in the next phase Use of proprietary technology would require ongoing purchase of data and services
INRIX 3rd Generation Routing	Dynamic routing	Proprietary routing engine	Forecasts changes in traffic conditions during a trip, with turn-by-turn directions for alternate routes Can be combined with fleet services like next-day planning, road weather, fuel prices, and dispatch services	Time savings Fuel savings Dispatch efficiency	Offers services relevant to trucks, but not customized specifically for commercial operations	
NAVTEQ Truck Routing	Dynamic routing	Proprietary routing engine with truck-specific navigation	Includes known height, weight, and other truck restrictions in route recommendations	Time savings Fuel savings Dispatch efficiency	Comprehensiveness of truck route coverage unclear	
Google Maps Navigation	Dynamic routing	Free routing and traffic app for Android	Can search for alternate routes and accepts voice commands	Time savings	Still in beta testing Not truck-oriented	N/A
Qualcomm In-Cab Navigation	Dynamic routing, Fleet management	Truck-oriented in-cab navigation	Specifically geared towards trucks with truck-restricted routing and route compliance monitoring for dispatchers	Time savings Fuel savings Dispatch efficiency Driver settlements Hazard avoidance	N/A	N/A

Technology/ Program/ Project	Functional Area(s)	Description	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
PC*Miler	Route and mileage calculations	Commercial software package for truck routing	Optimizes itineraries by user-defined parameters; calculates precise mileage for billing/payroll	Time savings Fuel savings Dispatch efficiency Driver settlements Hazard avoidance	N/A	N/A
Garmin	Navigation	In-cab GPS devices for trucks	Route calculations based on predicted traffic flows; alternate routing by time, distance, other parameters	Time savings Hazard avoidance	Truck GPS devices offer many useful features for truckers but this is not Garmin's core business	N/A
Rand McNally IntelliRoute	Navigation	Routing software for fleet managers, in-cab GPS devices for trucks	Leverages firm's history in truck routing/mileage services	Reduced operating costs Time savings Fuel savings Hazard avoidance	N/A	N/A
Teletrac	Navigation, fleet management	GPS tracking and fleet management software and hardware developer	Sophisticated truck tracking, including satellite tracking at microlevel locations and status updating	Reduced out-of-route miles Fuel savings Time savings	N/A	N/A
Automated OS/ OW Routing and Permitting	OS/OW operations	Software utilities for automated permit issuance and routing	Can automatically generate approved routes for OS/OW loads under certain circumstances	Reduced infrastructure deterioration Reduced bridge strikes Safety	Timely and accurate construction information Centerline-based networks with point interchanges do not support advanced routing capabilities	Complicated loads will likely always require some manual intervention

Technology/ Program/ Project	Functional Area(s)	Description	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
Dynamic OS/OW routing	OS/OW operations	Concepts for dynamic OS/OW routing	Ability to reroute overdimensional loads over appropriate roads	Reduced infrastructure deterioration Reduced bridge strikes Safety OS/OW efficiency	Timely and accurate construction information Driver participation/trust Connecting legacy permit systems to 511 systems Network data are not always available in enough detail Data maintenance can be burdensome	N/A – Conceptual systems only

4.1 Commercial Off-the-Shelf Routing Applications

Advances in traffic avoidance and prediction technologies coupled with new methods of data integration have resulted in a new generation of dynamic routing capabilities, largely delivered through smartphones and consumer GPS devices. Four recent technologies are profiled below.

TomTom Truck Navigation

TomTom has developed a multicountry mapping and navigation database to support commercial vehicle routing. The system includes truck-specific attributes such as state and local designated truck routes, bridge height and weight restrictions, hazardous materials routes, and routes for longer combination vehicles. A user feedback loop allows users to submit data about restrictions which do not appear in the database; upon verification by TomTom, the new information is included in the database. Most of the truck route information is provided by ProMiles, a commercial firm which supplies truck routing services and mileage calculations for fleet managers. These network attributes are geo-coded and overlaid on a centerline road network to generate routing appropriate for large trucks. For example, locations of height restrictions are attributed to road segments to prevent routing of large trucks on those roads.

TomTom's commercial vehicle navigation is enhanced by real-time traffic data gathered from multiple sources. The firm's traffic data fusion engine collects input data from several sources, including TomTom navigation devices, smartphones acting as vehicle probes, third party data providers, road sensors, and incident information from public agencies. This data is collated and stored in a cloud environment for distribution to subscribers. Reports can include real-time incident locations, estimated route times, and link flow speeds. Speed profile data are generally available for each five-minute period of the day and each day of the week.

TomTom also provides fleet management software and applications, including vehicle locating, job status updates and two-way messaging between dispatchers and drivers, and vehicle performance data such as hard braking events and idle time. Dispatchers can send new orders via text (or text-to-speech to minimize distracted driving) and drivers can provide order workflow status updates as they complete key events such as pickup or unloading. System-calculated ETAs are reported to the firm's proprietary WEBFLEET fleet management portal for real-time workflow tracking. WEBFLEET has a dashboard reporting capability for tracking performance indicators such as orders per day and daily mileage.

INRIX Route Guidance

INRIX is a leading provider of traffic information and driver services based in Seattle, Washington. INRIX maintains a traffic data network, including over 10 million GPS-enabled vehicles from more than 400 sources, and encompassing major roadways in 20 countries throughout North America and Europe. Using this data, INRIX has developed mapping and route guidance applications, including its latest Third Generation Routing Engine. This application uses the firm's Total Fusion technology – which blends real-time traffic flow data from approximately 10 million GPS-enabled fleet vehicles and consumer cellular GPS-based devices with road sensor data – to provide "time-intelligent" routing services. The Third Generation Routing Engine incorporates real-time, historical, and predictive travel time information, enabling the application to determine how traffic is expected to change during the course of the trip and advise the user accordingly.

INRIX also has a Fleet Services division, providing services in many areas to commercial users:

- **Dispatch Services** provides access to speed information and real-time incident alerts for city streets, arterials, and major freeways to dispatch staff to enable the best routing decisions;
- **Next-Day Planning** allows subscribers to optimize delivery schedules using predictive and historical traffic data with real-world expected travel times between stops;
- **Traffic Map Overlays** lets users add real-time traffic to existing mapping applications;
- **Congestion Pricing** allows users adjust pick-up and delivery costs based on expected impacts of traffic on travel time and fuel use;
- **Fastest Routes and Precise ETAs** uses the Third Generation Routing Engine to get precise routes and accurate ETAs; and
- **Driver Services** includes traffic within navigation capabilities, traffic along the driver's route, and traffic maps to allow commercial drivers to avoid traffic delays and maximize efficiency under Hours of Service and other regulations.

NAVTEQ Truck Routing

Like INRIX, NAVTEQ is primarily a data provider. The company specializes in the provision of digital map data for use by automotive GPS systems, wireless devices, and Internet-based mapping applications. NAVTEQ has a Fleet and Logistics division which provides location and map data for use by fleet managers. Specialty fleet data products include:

- NAVTEQ Transport, which is designed specifically for the commercial trucking industry with route recommendations that account for known restriction attributes like legal height, weight, length, and width specifications. The system also can provide advance warning of truck hazards like steep grades, sharp curves, and high lateral winds.
- Integrated navigation to connect fleet back office IT systems with in-vehicle navigation, thus enabling two-way communication for route calculation and deliver fleet optimization; and
- A fuel station data set covering over 17,000 gas stations in Europe with data on accessibility by trucks, type of fuels sold, and payment options.

These applications are typically run on top of a client firm's existing fleet optimization/dispatch software. For example, Coca-Cola's European bottler and distributer used NAVTEQ route and location information in conjunction with ORTEC Vehicle Routing and Dispatch software. This allowed dispatchers to plan optimal routes (minimizing miles and driver hours) in less time while determining better overall delivery strategies. According to a case study on NAVTEQ's web site, this solution saved Coca-Cola $45 million annually.[14]

[14] http://corporate.navteq.com/media/CaseStudy_Ortec_CocaCola.pdf.

NAVTEQ map and navigation data also have been integrated into asset and cargo tracking systems for logistics companies. GEFCO, a European logistics firm, used NAVTEQ map data (including turn by turn directions and travel times) in conjunction with a GPS tracking solution provided by another company to track trucks and cargo across Europe. Truck position information is sent to a server every 15 minutes, improving shipment visibility for GEFCO and its customers. The GPS devices are "plug and play" so they can be easily moved between trucks. One key advantage of the solution is that it offers a single provider for both the telecom and fleet subscription.[15]

NAVTEQ digital map data is available in traditional GIS data formats and also in Relational Database Format (RDF), permitting direct integration into relational database applications like Oracle 10G/11G, IBM DB2 and Microsoft SQLServer. This makes it directly accessible through spatial extensions of those applications, reducing data integration time.

Google Maps Navigation

Google Maps is beta testing a new mobile mapping application, providing Internet-connected GPS navigation with voice guidance. Although the application is not freight-specific, it can search for alternate routes and provides real-time traffic information and trip times. It also accepts voice commands for destinations and can search by destination name, thus negating the need to know the exact address. The app provides color-coded traffic data describing current traffic conditions on a route. It also can switch to satellite and street views, allowing users to visualize turns using landmarks. The app automatically switches to the street view as a user nears the destination. The app is available for free via the Android Market.

Data and Communications

- Data are gathered from many sources, including public agencies (e.g., incidents, delays), GPS probes in vehicles, and road sensors. The information is collated by proprietary traffic and routing engines, then stored on a server and distributed to users.

Conclusions

Taken together, these applications suggest that alternate routing systems already are fairly advanced in the private marketplace. The existence of a free Google app with some of this functionality implies that the technology is indeed somewhat ubiquitous, at least for passenger travel. TomTom may have developed the first dynamic truck routing capability using a centerline road network with truck-specific attribute data. This presents an opportunity to leverage this cutting edge technology in the next phase of FRATIS development, by incorporating truck-restricted routing capabilities into an existing deployed dynamic routing system.

[15] http://corporate.navteq.com/media/CaseStudy_FT_Gefco.pdf.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
TomTom Truck-Specific Navigation	Commercial truck navigation and proprietary routing	Incorporates truck-specific attributes in roadway network	Commercial vehicle flow data are not yet broken out separately in link flow and other reports	WEBFLEET reporting with sample fleet data from participating carriers could be used for a dynamic routing test
INRIX 3rd Generation Routing	Proprietary routing engine	"Time-intelligent" routing goes beyond traffic avoidance capability	Not customized specifically for truck movement	Potential opportunity to offer truck restricted routing through the dynamic route guidance engine
NAVTEQ Truck Routing	Commercial truck navigation and routing	Includes height, weight, and other restrictions in routing	Comprehensiveness of truck route coverage unclear	Another potential option for dynamic truck routing
Google Maps Navigation	Free routing and traffic app for Android	Free; can recognize voice commands for directions	Not freight-specific	The information and routing algorithms for this type of application are becoming ubiquitous

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4.2 Custom Truck Routing Systems

Beyond the systems outlined above, there are several truck GPS and fleet management software providers specializing in providing navigation and business process solutions for commercial fleets and truck owner-operators. The market leaders in this area are profiled here, along with the implications of these systems for FRATIS.

Qualcomm In-Cab Navigation

Qualcomm provides a suite of in-cab navigational aids targeted specifically towards commercial vehicles. CoPilot Truck is a customizable navigation application providing digital mapping enhanced with truck-specific attributes and points of interest which are loaded directly into a mobile computing platform (MCP). Drivers can input desired parameters such as toll avoidance; routes suitable for 53-

foot trailers/twins; and practical miles/shortest miles,[16] or National Network.[17] The software also can provide HazMat routing, route restrictions, and trucker points of interest like weigh stations and truck stops. Drivers can enter up to 50 stops on their itinerary to determine optimal routing, and the software bases routing decisions partially on factors like vehicle size and load type to help minimize tolls and fuel use. The system provides audible directions with street names and a visual display with large, clear arrows to minimize driver distraction. CoPilot is preloaded with industry standard PC*Miler maps and truck-specific attributes.

Qualcomm provides another service called Maptuit NaviGo, which provides near real-time navigation, including a dynamic routing feature. This includes near real-time position reporting with rerouting capabilities, as well as a route compliance feature enabling dispatchers to assess how well their drivers are following plans. The GPS tracking capability also can help drivers and dispatchers avoid truck-restricted routes, residential areas, low bridges, and other truck-specific hazards.

PC*Miler

PC*MILER is a trucking-oriented software package which can generate point-to-point truck-specific mileage, routes, driving directions and maps covering the highway systems in North America, Puerto Rico, Bermuda, and Greenland. It is considered a leader in this field and is used by 96 of the top motor carriers in the United States.[18] It also is used by government agencies, including the FMCSA as a distance standard for auditing purposes. Mileage generated by the software relies on numerous sources, including FMCSA, official state highway maps, state DOT maps, county maps, local maps, historical truck traffic and related GPS sightings, and information from industry contacts. Like Qualcomm, PC*Miler can provide practical routing, shortest routing, and National Network routing (in fact, Qualcomm's CoPilot Truck relies on PC*Miler for mapping and distance calculations). These can be combined with restrictions related to toll avoidance and 53-foot long/102-inch-high trailers. A separate HazMat module can generate point-to-point distances and driving directions for hauling hazardous materials and dangerous goods while ensuring compliance with applicable regulations in the United States and Canada. Routes can be generated for general hazmat, as well as caustic, explosives, flammable, inhalants, and radioactive materials.

From a routing perspective, users can enter a route with an unlimited number of stops. The software calculates miles between stops, cumulative miles from origin, cumulative trip cost, and cumulative drive time. Toll costs also can be calculated using a separate module. Truck-restricted roads are highlighted in yellow on PC*Miler maps, but can be overridden manually. A detailed route report provides road type information (state, toll, or free road), direction of travel, route, segment distance, driving time, interchange point, leg mileage and time, cumulative trip mileage and total trip time. A route resequencing feature reorders the stops entered in the route entry window, keeping the origin

[16] Practical miles are generally considered the best routes for large trucks to take, based on roadway characteristics and travel time. Shortest miles (also called "household goods miles") refers to routes that are shorter in terms of distance but frequently take longer because they use roads of lower functional classifications. Trucking companies usually pay drivers based on shortest distance miles, even though drivers will almost always take the practical miles route to save time.

[17] The National Network is the network of state and Interstate highways approved for commercial truck use in the U.S., authorized by the Surface Transportation Assistance Act of 1982. Federal width and length limits for commercial vehicles apply on these facilities.

[18] http://www.axonsoftware.com/brief_intro_to_pcmiler.html.

the same, to provide the optimal order of stops. Users can optimize by total time, total distance, toll distance, or National Network distance.

Garmin

Garmin produces a series of GPS navigation aids designed for truckers. All of them can provide voice prompts with spoken street names, though none can be operated by voice command. Truck-specific routing can be customized by height, weight, length, and hazardous materials. A "TrafficTrends" feature available on some models calculates routes and arrival times based on predicted traffic flows. Truck-specific capabilities on some models include IFTA fuel logging, HOS violation warnings, exit services (food, fuel, etc.), and an external input for backup cameras. The devices can auto sort multiple destinations to find the most direct route, and can provide alternate routing by different criteria like fastest time, shortest distance, avoiding highways, or avoiding tolls. The devices also warn truckers of upcoming hazards such as steep grades, high cross winds, and sharp curves.

Rand McNally

Rand McNally also provides truck routing software. Its IntelliRoute software package leverages the company's long history in the commercial truck routing market (it has provided services to the industry, including household goods and practical miles routing, for more than 70 years). The software uses a street-level routing database, including about 6.7 million miles of truck attributed roads, which it uses to develop point-to-point routing for the United States, Mexico, and Canada. Routes can be customized by different trailer configurations, such as 48-foot, 53-foot, hazmat, and double/triple. Like other mileage/routing packages, it can calculate both practical and shortest miles. Truck-specific tolling data allows fleet managers to estimate toll costs, while a "RoadWork" feature provides construction project information, updated every two weeks. The software can optimize multipoint routing, and can provide lowest-cost routes based on maximizing fuel economy or controlling toll expenditures. Hazmat routing can be optimized to any one of 10 hazmat classifications. The firm claims to have 35 percent more truck restrictions in its data set than other solutions.

The firm also produces GPS devices for truckers. The IntelliRoute in-cab devices feature driver-controlled auto rerouting capability, which allows the driver to pause and resume rerouting calculations, reducing unnecessary in-cab voice and directional activity. A traffic predictor incorporates historical traffic patterns into route recommendations, and a live traffic feed is enabled via an accessory. They also provide a "junction view" with lane guidance, helping truckers navigate complex interchanges in 3-D. The system can automatically cross-reference to Rand McNally's printed road atlas. Like the Garmin series, these devices can warn drivers about speed limit changes, steep grades, and sharp curves.

Teletrac

Teletrac provides GPS tracking and fleet management solutions for commercial fleets. The firm's signature product is Fleet Director, a browser-based software package delivered as a subscription service. The software is designed in a modular fashion so that it can be customized to client requirements. The system provides 24/7 truck location data and status updates such as loading, loaded, or unloading; on route or off route; and detailed start, arrival, and departure times. Navigational aids provide verbal directions through an in-cab GPS display. Dispatchers can plan routes automatically by selecting vehicles and entering destinations, after which the system calculates optimal routing and uploads it automatically to the driver's in-cab unit. The system integrates live traffic data to facilitate better dispatch operations. Teletrac also has an integrated satellite mapping

function which provides even greater location detail, for example to confirm arrival at the correct entrance or loading dock. Vehicles that are designated as Class 8 trucks in the Fleet Director system only receive routes suitable for large trucks. A "nearest-vehicle" feature identifies the truck closest to a move so dispatchers can make the best asset allocation decisions.

The firm uses dedicated tracking equipment designed in-house for all applications. These include messaging devices, navigation displays, and GPS tracking systems. All of this is integrated into the Fleet Director software package.

Data and Communications

- Companies use proprietary map databases with link attributes to provide custom services like truck routing based on known route restrictions, toll avoidance, or practical/shortest miles. Some firms also have proprietary mobile computing platforms to deliver information to drivers, including GPS navigation and two-way messaging.

Conclusions

The table below summarizes the state of the practice in truck-customized routing. Some providers (such as Garmin) focus on truck GPS hardware only, while others (like Qualcomm and Teletrac) offer a suite of fleet management applications and software in addition to mobile computing platforms. PC*Miler specializes entirely in software and is a provider of truck-oriented mapping solutions to other companies like Qualcomm.

Although virtually all of these applications and devices offer truck-specific routing (e.g., hazmat, routes suitable for 53-foot trailers, etc.), they are not necessarily "dynamic" in the sense that a truck could be rerouted in real-time around congestion or an incident. Rather, they tend to be targeted towards trucker points of interest and overall route optimization (although traffic data feeds in some applications do offer the ability for dispatchers to exception manage). Taken collectively, this factors point to a potential opportunity for FRATIS to develop and deploy a true dynamic routing capability for trucks which is missing in the marketplace today.

In comparing these technologies to the data-oriented services provided by firms like Google and INRIX, it is apparent that GPS navigation aids and fleet management applications have been in use for some time while new routing applications (often Smartphone-based) are relatively new. The traditional hardware and software combination approach offers some advantages such as a robust reporting and analytical capability, but these solutions tend to be expensive since they require the purchase of a mobile computing platform for each truck (typically $800 and up) plus monthly service fees. The chief advantage of using location-based Smartphone technology is its low cost, although they may not be able to provide the same data richness that traditional systems do. Nonetheless it is apparent that dynamic routing will increasingly be delivered through smartphones in the future; for FRATIS, there may be an opportunity to leverage this trend to identify specific public benefits (e.g., emissions reduction) associated with this.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Qualcomm In-Cab Navigation	Truck-oriented in-cab navigation	Specifically targeted towards trucking industry	Dynamic routing feature is "near real-time"	Potential opportunity for FRATIS to develop a truly dynamic, real-time truck routing capability
PC*Miler	Commercial software package for truck routing	Users can enter unlimited number of stops and optimize routing by different parameters	N/A	
Garmin	In-cab GPS devices for trucks	In-cab GPS units designed for truckers	Not the firm's core business area	
Rand McNally IntelliRoute	Routing software for fleet managers, in-cab GPS devices for trucks	"Traffic predictor" incorporates historical traffic info into route recommendations	N/A	
Teletrac	GPS tracking and fleet management software and hardware developer	"Nearest vehicle" locates truck closest to a given move	Requires purchase of Teletrac hardware	

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4.3 Dynamic Oversized/Overweight Permitting and Routing

Even though some of the private sector solutions described in Section 0 purport to offer routing for oversize/overweight (OS/OW) trucks, it is not always clear where they obtain data to make route recommendations for these vehicles. In some cases it is from state OS/OW permitting agencies that may not have up-to-date data themselves. Moreover, it is unlikely these software applications are equipped to handle extremely large loads. In any event, there are legal restrictions to true real-time dynamic routing of overdimensional loads. Nonetheless there have been advances in automated route generation for OS/OW loads which may have implications for FRATIS. Challenges primarily revolve around the accuracy and timeliness of information updates (particularly construction projects), and state resource constraints.

Current Routing Scenarios

Unlike the previous technologies, dynamic restricted truck routing is tied to a legislatively mandated activity: permit review and issuance by state agencies to enable vehicles exceeding legal size and weight limits to travel on national, state, and occasionally local highways. Routing applications of various levels of sophistication have been deployed for over a decade, and jurisdictions use additional techniques to reduce the variety of scenarios which the routing applications must consider.

States have implemented four basic types of route generation systems:

- **Multitrip Route Networks –** A defined envelope of overdimensional and overweight vehicles which qualify to buy a single permit that is valid for multiple trips. Depending on the jurisdiction, permits may be available for a month, quarter, or year. These permits are issued to vehicles whose size and weight would typically enable permits to be issued with minimal travel restrictions or escort requirements, and no structural or pavement analysis. It is normally the carrier's responsibility to "check the route" before travel. Some states offer web portals for this purpose.
- **Envelope Routing Systems –** The issuing agency has made the decision to "prescreen" a number of commonly used routes (or route segments) and generate a menu of available route options to carriers fortunate enough to be traveling between origins and destinations of relevance. These types of systems have been in place for over a decade, most notably in Tennessee and Indiana.
- **Centerline-Based Map Route Selection –** Map-based interfaces with a route selection function. Data limitations often necessitate a centerline-based map, which entails limitations in terms of path (the system only recognizes on per highway) and other attributes such as interchange characteristics. Most of these systems provide a "check-route" function for multitrip permit holders or for single-trip permit holders concerned about new construction.
- **Network-Based Map Route Selection –** The newest generation of map-based automated route selection systems utilize the agency's existing geo-coding of data, and therefore link with a variety of internal agency systems. Texas and Oklahoma have recently deployed these types of systems. Because they use a wider range of data and use data as it is updated, they are the best candidates for a platform for dynamic rererouting for incidents and construction, as well as applications in other areas of restricted travel such as hazardous materials transport. The drawback of these systems, however, is that they require frequent data updates from disparate sources, which can create challenges in terms of data format and timeliness.

Automated Permitting and Route Generation

There are a few software packages specifically developed to assist states with OS/OW permitting and routing. Three common systems are described here.

Bentley Advanced Routing and Permitting System

The Bentley Advanced Routing and Permitting System (ARPS) is the oldest and biggest application in this market. The system enables on-line permit application, issuance, and processing of payment. A digital base map with attribute data, including infrastructure parameters such as bridge capacities and construction activities generates automated OS/OW routing based on the information provided by the

carrier electronically. Software utilities enable customers to update road, bridge, customer, and permit data as necessary to maintain the system.

One weakness of Bentley's system is that their maps only have point data for interchanges, which means they cannot support detailed or complex route operations such as ramp-off and ramp-on.

Texas ProMiles Permit System (TxPros)

ProMiles is a private firm offering truck mileage and routing services similar to PC*Miler. However, for the Texas Department of Transportation (TxDOT), ProMiles has implemented a custom OS/OW routing system called TxPros. TxDOT developed the new system in response to the recognized inefficiencies associated with manual permitting and routing, e.g., errors and delays in permit issuance. TxPros relies on available TxDOT highway system data combined with geo-coded Permit Map data. TxDOT has realized benefits in terms of improved highway safety and infrastructure preservation, as well as reduced errors and improved fee collection. Most routine permitting is done by the carriers on a self-serve basis through the web portal, freeing up staff to focus on more complicated permits or enforcement. Customers experience reduced permit turnaround time since permits are issued automatically for "normal" OS/OW loads. Carriers can manage their own accounts, authorized users, and other pertinent information, reducing the need for them to contact TxDOT directly to update information. Permit restrictions are updated in real-time with a "new-restriction-alert" feature for active permits. Restrictions on specific highway links are highlighted in red on the route maps, and users can call up a window listing the specific restrictions on each segment.

Intergraph Automated Routing for OS/OW Vehicles

Similar to Bentley, Intergraph's Automated Routing for Oversized/Overweight (OS/OW) Vehicles application integrates bridge load information, construction project status updates, and other roadway characteristics with a digital base map to provide automated routing for oversize loads. Goals are to improve heavy duty vehicle safety, preserve transportation infrastructure, and streamline the overall permitting workflow process. The software is Internet-based. Intergraph provides a suite of software for roadway information management, of which the OS/OW package is one module. The system uses a centerline-based map layer interfacing with road, bridge, construction, and other data to generate routes. It can interface with third party data providers such as NAVTEQ for network modeling. A route planning feature lets users generate custom routes through a map interface or using points of interest such as intersections or company names.

Data and Communications

- Automated routing applications use centerline-based maps with OS/OW feature layers to generate routes via a web portal.
- Automated permitting provides a self-service portal for OS/OW carriers for entering shipment information, self-issuing permits, and managing payments and other administrative functions.

Conclusions

The market for automated OS/OW routing and permitting has been evolving over the years, with advances driven by the availability of richer data describing network restrictions and temporary conditions such as construction. In terms of routing, all of these systems rely on the integration of

geo-coded roadway information – such as bridge clearances/load restrictions, construction data, and lane widths – with a digital base map to enable automated route generation. Permitting has been expedited too through self-service functions where carriers can enter the pertinent load information themselves, self-issue the permit, and provide payment through a web portal, at least for more routine OS/OW loads. Really large loads, however, will likely always require some manual intervention. Maintaining and updating the detailed highway network, construction, and other data required for these systems will likely remain a challenge for many agencies.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Automated OS/ OW routing and permitting	Software utilities for automated permit issuance and routing	Improved data is expanding the functionality of these systems	Data timeliness/ accuracy is a concern Many systems use point interchange data which cannot support advanced ramp-specific routing	It is possible to automate most routine OS/OW permitting and routing but complicated loads will likely continue to require manual intervention

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Cambridge Systematics Concepts to Support Dynamic Restricted Routing

As the previous discussion has shown, the market for automated permitting and routing is fairly advanced. However, dynamic *rerouting* at the carrier's discretion is something that in most cases is prohibited by the terms and conditions of the issued permit. Law enforcement officials have the authority to dynamically reroute as part of incident management, but generally lack the in-vehicle technology to do so without assistance from staff of a permitting agency. When considering the ability to provide additional tools to the carrier community to facilitate traveler information and dynamic (re)routing, a spectrum of potential solutions can be contemplated. CS has developed six concepts for dynamic OS/OW routing. In order of increasing complexity/cost, they are:

- **Carrier-Initiated 511 – Basic.** Of the six potential solutions, this is the most basic one that requires the least amount of setup for an agency. Under this option, it would become a requirement for carriers or carrier support to dial 511 or access 511 on-line before commencing their shipment in order to receive the latest incident and construction information. The carrier would become informed of incidents and

construction information through automated messages based on the route they select. Although this method would not require resources beyond existing 511 staff, its effectiveness could be limited because of probable difficulties in matching the permitted route in the 511 system, especially if the former is circuitous to avoid certain roads that cannot handle large trucks.

- **Carrier-Initiated 511 – Enhanced.** This option is an enhanced version of the Carrier-Initiated 511 – Basic concept. It addresses one of the primary deficiencies that option, which is the capability to link 511 and the routes identified by Special Permits. Carriers or support would access 511 before the shipment and enter a unique identifier to receive incident information on the route specified for them by the permit office. 511 programming resources would be required in order to facilitate the link between 511 and the unique identifier.
- **Special Permit 24-Hour Hotline.** This option differs significantly from the first two in that the carrier will make contact with a Special Permit 24-Hour Hotline operator prior to shipment, as opposed to relying on 511 technology for incident information. The Hotline is assumed to be operated by the Permitting Office during normal business hours, taking advantage of their familiarity with clients and customer service focus. During non-business hours, should the agency have a 24/7 traffic operations group, calls would be directed to this department. This option requires additional operations work from existing or new staff to monitor the Hotline as well as internal agency communications that can support fast lookup of incidents on primary and alternate routes.
- **Daily Updates to Special Permit Holders.** This concept relies on "pushing" information out to Special Permit holders to give them the daily updates (via e-mail, text, and accessible via limited access web site) on incidences and lane closures affecting the OS/OW Corridor Network. Special Permit Holders would receive a daily message, possibly with a map included, that would enable them to review their primary and alternate routes. The concept of limiting updates to one per day is to prevent flooding Special Permit holders with messages that do not apply to their routes. This task could be highly automated through the 511 system. Staff would be needed to review daily messages prior to their broadcast. A limited access web site (or extranet program) would need to be maintained and updated daily with the latest closures.
- **Targeted Updates to Special Permit Holders.** This concept, similar to Daily Updates, relies on "pushing" information out to Special Permit holders (via e-mail, text, and accessible via limited access web site) on incidences and lane closures affecting the OS/OW Corridor Network. In this case, updates are sent to only those carriers who have activated their load by calling in to a Special Permit 24-Hour Hotline (required if they plan to move within 24 hours). Once their load is activated and primary route noted, Special Permit holders are clear to begin their shipments. They are required to maintain e-mail/text access (driver or carrier escort) lines of communication with the agency. Designated agency staff would monitor the OS/OW Corridor Network and cross-reference any new incidents with the loads currently using the Network, sending e-mail/text updates to any loads on routes with new incidents. Drivers are then required to review their route and adjust accordingly. Agencies would have to monitor the OS/OW network and determine when it is appropriate to notify active loads of incidents, and maintain the 24-hour hotline as in

the third option. Carriers would have to maintain mobile text and/or e-mail accessibility for the duration of their shipments.

- **GPS-Based Fleet Management.** This option would allow an agency the highest degree of accurate, real-time tracking of active Special Permit holders. This option requires a significant investment by the carriers in GPS-based location devices, as well as an increased monitoring workload for agency staff. With this system, an agency would be able to track these movements from start to finish and contact carriers immediately via e-mail/text when incidents/lane closures arise in their path. Carriers and/or carrier support would be required to maintain communication with the agency throughout their shipment and also call the Special Permit 24-Hour Hotline prior to their departure. Agencies wishing to implement this system would have to invest in fleet management software with GPS tracking, and also would have to have (or implement) a Special Permit 24-Hour Hotline. Carriers and/or carrier support would be required to invest in and maintain registered GPS-based location devices (which may include cellular phones) and maintain e-mail/text communication capabilities with the agency. Geo-fencing could be included in this option as an enhancement.

Data and Communications

- Varies; ranges from basic (carrier contacts 511 telephone line or web site prior to move to obtain data on any OS/OW restrictions applicable to the route) to advanced (automated GPS tracking and electronic notification of incidents or lane closures in the carrier's path).

Conclusions

As the discussion above makes clear, there has been substantial research into automated/dynamic routing systems for OS/OW loads. Some states have deployed such systems which can automatically generate appropriate routing for these trucks. However, the most advanced systems are very data hungry, and many states lack the geo-coded transportation network data in sufficient detail to support these systems. Even states that do have data at the right granularity often have trouble maintaining it to support OS/OW operations continually. The timeliness and accuracy of construction data is a particular concern for overdimensional movements. Because of these constraints, the routing of OS/OW trucks will likely always include some manual effort by permitting staff. Having said that, there is potential to link existing 511 systems with legacy OS/OW permitting systems, but there may still be issues related to data accuracy/timeliness and staff resources at permitting agencies.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Dynamic OS/OW Routing	Concepts for dynamic OS/OW routing	Advanced options would permit real-time monitoring and routing for OS/OW loads	Data timeliness/ accuracy Resource constraints – the most advanced systems require nearly constant data updates	Linking legacy permitting systems to existing state 511 systems has potential but relies on timely/accurate data and sufficient staff resources

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5.0 Terminal Queue Status (Including Video)

Long queues of trucks at intermodal terminals are a recurring feature of many urban areas, especially those around major port complexes and large intermodal rail hubs. These trucks create safety, traffic, and emissions concerns for the surrounding community. Queues result when a ship arrives in port, resulting in a scramble by shippers to get their containers; when terminal operators have labor shift changes; when a part of a marine terminal is closed off for some reason; and for a variety of other reasons. Dray truckers and dispatchers oftentimes are not aware of long queues at the gates until they arrive, and are therefore powerless to reallocate resources to avoid the lines, for example by picking up an available load at another terminal.

Queue detection systems can alleviate this issue by sending push alerts to interested parties when lines reach a certain predefined length. Prior demonstrations have utilized changeable message signs to provide such alerts. A newer system might employ notifications through mobile devices or other means. Many port terminals also have installed video cameras which provide an image feed to a web site so drivers and dispatchers can view traffic conditions in real-time. The WSDOT Intermodal Data Linkages Freight ITS Study profiled below found this to be a popular feature despite hiccups encountered with the rest of the test which ended up limiting participation. (This finding was subsequently confirmed in the FRATIS user surveys, where users of travel information web sites ranked camera feeds as the most important feature.) Indeed, the existence of a privately owned and operated web site (seattletrucker.com/latrucker.com) which brings together public web cam links of terminal conditions at the ports of Los Angeles/Long Beach and Seattle indicates that this information is valued by the intermodal drayage community.

There also are newer wireless sensor systems which can be used for queue detection and are cheaper to install than traditional traffic detection systems such as inductive loops. Some of these make use of Bluetooth technology to detect Bluetooth-capable vehicles or mobile devices in the traffic stream and measure queues and wait time; others involve small sensors embedded in the road surface which transmit information to Internet-connected access points.

Table 5-1 summarizes prior and current efforts in this area.

Table 5-1. Assessment of Terminal Queue Status (Including Video) Systems

Technology/ Program/ Project	Functional Area(s)	Description	Scope and Timeframe[a]	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
WSDOT Intermodal Data Linkages Freight ITS Study	Truck GPS tracking Congestion management	Deployment of congestion management systems at Ports of Tacoma and Seattle	Large 1999-2003	Proved several concepts related to freight-oriented ITS	Truck redirection around congestion near a port	Limited test of queue detection system due to interchange reconstruction project which negated the need for it	Freight-specific ITS deployments have merit and are desired by the freight community
Seattletrucker.com	State and local traveler information	Private web site with links to port traffic cameras in Seattle and Los Angeles	N/A	Real-time camera feeds in one place for easy access	N/A	N/A	N/A
Sensys Networks Queue Detection System	Queue detection	Wireless, in-ground sensors for traffic queue, volume, and speed detection	N/A	Comparatively low-cost option for queue detection	N/A	N/A	N/A
Freeahead Bluetooth Queuing and Vehicle Detection System	Queue detection	Bluetooth devices detect equipped vehicles and calculate actual travel times and current wait times from back of queue	N/A	Low-cost queue detection system utilizing existing devices in Bluetooth-equipped vehicles	Wait time accuracy	Did not meet 85% accuracy threshold established in border crossing tests but was among the most accurate of the technologies tested	It is important to ground-truth calculated wait time data to facilitate better system calibration

Technology/ Program/ Project	Functional Area(s)	Description	Scope and Timeframe[a]	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
Traficon Traffic Video Detection	Queue detection	Video image processors develop queue metrics based on camera feeds	N/A	Can leverage existing video feeds, e.g., at port terminal gates	Queue length accuracy	N/A	N/A

[a] Small – <$250,000; Medium – $250,000 to $1 million; Large – > $1 million.

5.1 WSDOT Intermodal Data Linkages Freight ITS Study

In mid-1999, the Washington State Department of Transportation (WSDOT) partnered with public and private organizations to test and evaluate two freight traffic ITS projects as part of a larger "Intermodal Data Linkages ITS Operational Test." The first part was a congestion management system consisting of queue detection linked to a variable message sign at the Port of Tacoma, and truck queue cameras at the Port of Seattle. These systems are described below. (The second part of the project was an early test of GPS data for transportation planning, and a similar test using DSRC truck transponders. Since these were not related to queue detection, they are not summarized here.)

- **Congestion Management Systems**. There were two parts to this test:
  - The first piece of this test deployed a traffic-measuring device at the first of two exits off of I-5 near the Port of Tacoma that would connect with a beacon sign installed upstream on I-5. This connection provided messages displayed in real-time to truck drivers regarding the level of congestion on that off-ramp, giving them the opportunity to take the second Port of Tacoma exit to avoid the congestion on the first one. The test was complicated by the concurrent completion of a major upgrade to the interchange in question, which negated most of the need for the queue detection system in the short term. Because of this, the congestion alarm was only triggered once due to a truck rollover; however the test did prove the concept that such a system could be successfully deployed.
  - The second portion of this test involved the installation of video cameras at several Port of Seattle terminal roadway approaches to monitor gateway and access road queues. These video feeds were made available to trucking companies and the public in real-time through the WSDOT traffic conditions web site. This test successfully deployed traffic cameras to aid in freight operations, which achieved significant use despite a limited customer set and a general lack of outreach to potential users. The cameras also provided ancillary benefits, such as allowing shippers and carriers to investigate the reasons for delays without contacting drivers directly.

Even though these projects and the associated evaluation were completed more than a decade ago, their results have likely informed ITS deployments in Washington State as well as subsequent U.S. DOT research.

Data and Communications

- Queue detection system transmits alerts to truckers via changeable message signs.
- Video feeds of traffic conditions provided to trucking companies via a webcam.

Conclusions

These tests collectively represent some of the earliest freight-specific ITS applications. While it is clear that some components encountered significant difficulties, the tests did successfully prove the concept of ITS deployments with tangible benefits to goods movement efficiency, as well as improved freight data collection for public agencies. The relatively heavy use that the port of Seattle traffic cameras received during the test implies that there may be promise in linking such freight-specific traveler information with existing 511 or similar systems.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Queue detection and camera-based congestion management	Deployment of congestion management systems at Ports of Tacoma and Seattle	Proved concepts of truck-specific ITS and GPS truck travel data Terminal queue video feeds were popular despite limited size of user group	Testing of the queue detection system was hampered by completion of an interchange upgrade	Integrating freight traveler information with existing travel information systems has some promise Video feeds are a popular source of queue information for the intermodal trucking community

References

U.S. Department of Transportation, *WSDOT Intermodal Data Linkages Freight ITS Operational Test Evaluation: Final Report, Part 2: Freight ITS Traffic Data Evaluation*, January 2003, available at http://ntl.bts.gov/lib/jpodocs/repts_te/13781.html.

5.2 Port Terminal Truck Queue Cameras

Many ports around the country have set up live webcams at their terminals which show truck queue lengths and are posted on the port's web site. These webcams provide a simple way for truckers working the harbors to assess queues at different terminals and plan their work accordingly.

One interesting recent development in this area is a web site (www.seattletrucker.com) which aggregates terminal queue webcam views on to a single site. The site was developed by a private company using publicly available sources. The main page contains links to webcams at different terminals at the Port of Seattle, which users can click on to get an enlarged view. The site also contains links to the Seattle/WSDOT Traffic Management Center and the company's Facebook page which has updates on news which affects the harbor trucking community, such as labor unrest and emissions regulations. Other links at the top of the page provide webcam views of key port access roads, with real-time travel time information between Seattle and various other regional points such as SeaTac Airport, Everett, and Bellevue. There also is a link to a webcam and traffic/weather conditions on I-90 over the Snoqualmie Pass. The company maintains a similar web site in Los Angeles.

Data and Communications

- Private web site links to several available data feeds that are publicly available, including traffic cameras, traffic operations centers, etc. The company's Facebook page also is linked to the site.

Conclusions

The SeattleTrucker.com site is an interesting example of a private actor using public data to deliver a value-added product to the port drayage community. Although it only covers Los Angeles and Seattle,

this concept could potentially be transferred easily to other locations, provided the necessary data feeds are available.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Port Terminal Truck Queue Cameras	Private web site with links to port traffic cameras in Seattle and Los Angeles	Aggregates traffic cameras into one place	Only covers Seattle and Los Angeles	Potentially scalable concept for FRATIS

References

www.seattletrucker.com.

www.latrucker.com.

5.3 Sensys Networks Queue Detection Systems

Sensys Networks is a provider of wireless traffic detection and integrated traffic data systems. Its signature product is the VDS240, which is a small wireless sensor device installed in the road surface which can measure traffic speed, density, and volume. Unlike traditional inductive loops, these sensors can be installed without trenching the road surface, making installation much quicker and less disruptive. Sensors interact with wireless Access Points mounted nearby to aggregate traffic data and send it to a central operations system. The system supports remote management, diagnostics, and configuration.

Besides being able to support real-time traffic data collection (an important input to FRATIS), the system can be used for truck queue detection purposes. Wireless sensors embedded in the roadway would detect trucks at two or more points on the approach to an intermodal terminal, thereby providing real-time data on the length of the queue.

Data and Communications

- In-ground wireless sensors communicate with Access Points mounted on traffic signals or existing poles. The Access Points are the gateways between the traffic sensors and the Internet. Proprietary server applications aggregate and manage the data generated, and can interface with third party ITS solutions and traffic controllers.

Conclusions

Although many queue detection technologies exist and are in use today, some of them such as inductive loops can be costly and disruptive to install, and are not easily scalable. Sensys leverages wireless communications to collect queuing information, using sensors that are quicker to install and easier to maintain than some older legacy technologies. This makes the system scalable and adaptable for changing operating conditions. As a method of gathering gate queue data, such a

system could prove a valuable input to FRATIS, but it would probably be dependent on having a local agency install the equipment at key locations approaching intermodal terminals.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Sensys Networks Queue Detection Systems	Wireless, in-ground sensors for traffic queue, volume, and speed detection	Easy to install Utilizes low-cost wireless technology	N/A	Could be used for wireless queue detection at terminal gates

References

Gateway Cities Council of Governments, ITS Vendor Showcase, January 10-11, 2012.

www.sensysnetworks.com.

5.4 Freeahead Bluetooth Queuing and Vehicle Detection System

Freeahead is an independent consultancy specializing in the development of ITS solutions. One recent project the company participated in was an evaluation of automated border crossing wait time technologies for the FHWA. Freeahead developed and implemented a system using Bluetooth technology at the Peace Bridge between Buffalo, New York and Erie, Ontario and the Pacific Highway near Blaine, Washington and Douglas, British Columbia. Of the four technologies tested for the project, Bluetooth proved to be one of the most accurate, based on a comparison of visually observed wait times with those calculated by the system.

Data and Communications

- Proprietary "BluFax" units read Media Access Control (MAC) addresses of Bluetooth-enabled vehicles/devices passing through the border approach area. MAC addresses and GPS time are sent via GSM to a cloud server, where the application calculates actual travel time and current travel time from the end of the queue. Data are reported in standard XML format using Traffic Management Data Dictionary (TMDD) standards.

Conclusions

Although it is not clear that this technology has been applied in an intermodal terminal environment, the successful test at two border crossings suggests that it could potentially be used for measuring queues and wait times at ports and intermodal rail terminals. Moreover, it is a low-cost and scalable option which takes advantage of the growing penetration of Bluetooth-enabled vehicles and mobile devices. It would be important to ensure adequate penetration of such devices in the truck fleet serving any potential FRATIS test bed site as this has a direct impact on the sample rate and therefore accuracy of the calculation.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Freeahead Bluetooth Queuing and Vehicle Detection System	Bluetooth devices detect equipped vehicles and calculate actual travel times and current wait times from back of queue	Scalable, low-cost solution Large and growing penetration of Bluetooth-equipped vehicles	Privacy concerns	Successfully tested at international border crossings; could potentially be used for terminal queue detection

References

Federal Highway Administration, "Effort to Test, Evaluate, and Deploy Technologies to Automate the Measurement of Real-Time Border Wait Times at United States-Canada Land Border Crossings," available at http://ops.fhwa.dot.gov/publications/fhwahop11025/bwt_techbrf.htm.

Sumner, R., "Border Wait Time," undated presentation.

Freeahead, Inc., "ITS Design and Implementation," available at http://freeahead.com/itsarchitecture.html.

5.5 Traficon Traffic Video Detection

Traficon specializes in traffic detection based on video image processing. The firm offers products covering automatic incident detection, traffic data acquisition, and intersection presence detection. The latter technology can be used as an alternative to inductive loops and other detection technologies. For intersection control purposes, the application can provide vehicle presence detection, queue length measurement, traffic counts, speed measurement, and pedestrian monitoring. Alarms can be created during system set-up to alert traffic managers when queues exceed a certain length.

Data and Communications

- Video presence and data detectors accept camera inputs and process visual images to derive metrics such as queue length, vehicle presence, speeds, and counts by vehicle class. Queue data is processed using "vehicle detection zones" which can be customized. Separate module establishes communication between software located on a central computer (e.g., at a traffic monitoring center) and the video image detectors via Ethernet communications. The Ethernet connection can support streaming video and real-time traffic data reporting.

Conclusions

The Traficon solution leverages video camera equipment that already exists at intersections and other points of interest to relay important traffic data to system managers. This capability could potentially be used in concert with existing web cams at intermodal terminal gates to measure queue length and send alerts when they exceed a certain threshold.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Traficon Traffic Video Detection	Video image processors develop queue metrics based on camera feeds	Customizable zones for queue monitoring	N/A	Could be used in conjunction with existing terminal web cams

References

www.traficonusa.com.

6.0 Appointment Status

Terminal appointment systems are used to coordinate terminal capacity with truck arrivals, in order to smooth out the flow of trucks to an intermodal terminal throughout the day, thus reducing queues and idling emissions while making better use of available terminal capacity. Ports and marine terminal operators (MTO) frequently use such systems to manage truck traffic. Supplemental systems, often provided by the same vendor, are used for chassis management, back office operations, equipment maintenance and repair, and container depot management. These tools may be integrated into a suite of applications covering all aspects of intermodal terminal operations. Providers also may offer custom software development or management consulting services.

Table 6-1 summarizes two major providers of port and MTO IT solutions as well as four implementations at different ports around the world. Advent's Port Community System includes a specific component for terminal appointment scheduling, with a web interface that allows users (dispatchers and shippers) to reserve appointment slots. Telvent provides a port management system that includes a capability to communicate key vessel arrival, unloading, and loading information to supply chain partners, including trucking firms and railroads. Either of these systems could potentially be used to support a FRATIS truck appointment system, provided all key stakeholders participate and share information.

Real-world implementations of appointment systems have had some issues. Voluntary systems – such as those that were initially deployed at the Ports of Los Angeles and Long Beach – often struggled to attract users as truckers often did not perceive a benefit to using them. Some systems, such as the one in Vancouver, cannot accommodate two-way moves, which means that truckers cannot drop off an empty box or loaded one for export and then pick up an import container in the same trip. Such a constraint could be fatal to a drayage optimization system. Therefore, the structure of any appointment system used by or integrated with FRATIS during any future testing phase bears careful consideration.

Trucking industry acceptance of mandatory systems seems to rest on significant reductions in total turn times and improvements in terminal reliability. Charges for no-shows and late arrivals are viewed as one-sided by the trucking community since there is typically no corresponding penalty on marine terminal operators if they fail to meet their commitments. The experience in Sydney, Australia may be instructive here, as ongoing friction between terminal operators and truckers led to a politically imposed solution which involves reciprocal noncompliance charges and independent oversight by a neutral third party. It also is notable that the appointment system in Sydney is one part of a comprehensive operational strategy which includes peak-period surcharges (similar to PierPass in Los Angeles/Long Beach) and continuous performance monitoring, with weekly publication of performance metrics on a web site. Technology such as RFID and GPS plays a key role in truck and terminal performance measurement here and assists in the settlement of disputes between the parties.

Table 6-1. Assessment of Appointment Status Systems

Technology/ Program/Project	Functional Area(s)	Description	Scope and Timeframe[a]	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
Advent Port Community System	Terminal Appointment Systems	Modular port and terminal management system. One of the modules supports truck appointment systems. Others support drayage truck registries, truck tracking, community portals, clean truck programs, and traffic mitigation programs.	N/A	Improved service to port drayage community Better terminal utilization Reduced congestion at the gates Leveling of truck traffic Better labor management Emissions reduction	Reduction in gate queues Reduction in criteria pollutants and greenhouse gases Reduction in truck turn time Reduction in unit labor costs	N/A	Appointment systems and other portwide improvement programs such as drayage truck registries require cooperation on the part of marine terminal operators
Telvent Management and Information System for Ports	Terminal Appointment Systems	Port management system focusing on coordination among port agents, entities, and port services on ships to manage ship arrival, unloading/ loading, and departure	N/A	Automates much of the berthing process Loading/unloading operations control Road/railway traffic control Can push information out to transportation companies, customs, and other stakeholders	Improved vessel turn time Reduction in gate queues Reduction in truck turn time	N/A	N/A
Port Metro Vancouver Container Terminal Scheduling System	Terminal Appointment Systems	Terminal reservation system at Port Metro Vancouver, British Columbia	N/A 2001-Present	Reduced truck queues Improved air quality	Reduction in gate queues Reduction in criteria pollutants and greenhouse gases	Unable to accommodate two-way container moves, which reduces truck utilization	It is important to coordinate appointment systems with a drayage optimization strategy to achieve maximum benefits in terms of reducing unproductive trips and leveling out truck traffic
Southampton, UK Truck Appointment System	Terminal Appointment Systems	Terminal reservation system at the Port of Southampton, United Kingdom	N/A 2005-Present	Reduced port wait times Improved air quality	Reduction in gate queues Reduction in criteria pollutants and greenhouse gases	Truckers still see queues as an issue in some instances No penalty for terminal operator when it fails to meet targets	Truckers see one-sided noncompliance charges as unfair
Long Beach Total Terminals International	Terminal Appointment Systems	Terminal reservation system at Total Terminals International, Port of Long Beach	N/A 2007-Present	Improved truck turn times Improved reliability	Reduction in truck turn time Container lifts per hour	N/A	Optimal solution may be different for each port/terminal
Sydney Ports Vehicle Booking System	Terminal Appointment Systems	Terminal reservation system at Port Botany, Sydney, Australia	N/A 1990s-Present	Improved truck turn times Reduced gate queues Leveling of truck traffic	Reduction in turn times Reduction in gate queues Truck arrivals in peak versus off-peak hours	N/A	Greatest benefits can be achieved through a comprehensive package of operational improvements, including off-peak programs and appointment systems with independent monitoring and reciprocal financial penalties for noncompliance

[a] Small – <$250,000; Medium – $250,000 to $1 million; Large – > $1 million.

6.1 Advent Port Community System

Advent is a provider of IT solutions for the intermodal transportation industry. Their Port Community System (PCS) is a modular technology solution geared towards ports and marine terminal operators. PCS was created to support terminal appointment systems, drayage truck registries, truck tracking, port community portals, clean truck programs, and traffic mitigation programs as well as various back office functions like fee management. Customers can select whichever modules are appropriate to their particular situation.

Advent's software package has been used to implement truck appointment systems in Los Angeles and New York:

- **APM Terminals Pier 400 Appointment System.** In 2010, the APM Pier 400 facility in Los Angeles implemented a gate appointment system using the Advent PCS Appointments module. APM Terminals realized benefits, including better labor management, leveling of terminal activity, improved terminal planning and equipment usage, and better service to the dray trucking community. The appointment system is web-based. Principal users include trucking dispatchers and consignees. Users reserve time periods for container pick up and drop off through the web site. The system can set different appointment slot time periods by day of week and transaction type. It also can set maximum limits on the number of appointments by transaction type, time period, and/or groups of yard blocks. The appointment system has a two-way interface with the terminal operating system (TOS) which is used to feed data to the gate transaction; appointment information also is visible to the TOS for yard planning and allocation purposes. The appointment system will be fully compatible with APM's future plans to develop an unmanned in-gate.
- **Port of New York/New Jersey Appointment System and Clean Truck Program.** In 2009, the five MTOs at the Port of New York/New Jersey banded together to evaluate the feasibility of a portwide truck appointment system. The key motivators here were the desire to provide better service to the local drayage community, level out terminal activity throughout the day, and better manage the labor required to operate the gates. The MTOs contracted with Advent to provide a portwide terminal appointment system. Subsequently, Advent also was selected to run the port's fledgling Clean Truck Program. Both programs were brought on-line in late 2011.

Data and Communications

- Users set appointments through the web-based appointment scheduling system. The overall PCS is comprised of a centralized database using port-specific data structures. A centralized EDI subsystem allows EDI messages to be exchanged with supply chain partners. Application middleware provides an interface with automation systems like RFID tags or GPS units. A reports engine supports data mining for canned or ad hoc reporting. A "business-rules engine" allows the client port or MTO to implement program-specific rules such as a maximum number of appointment time slots for a given day or time without the need for system reengineering or reconfiguration.

Conclusions

Advent PCS is an example of the sophisticated IT systems used by the intermodal industry today. If a port or terminal in any potential FRATIS test region were using such a system, it could be a valuable data resource for the FRATIS applications suite, assuming the port/MTOs were willing to provide a data feed. According to Advent, the overall success of any appointment system is dependent upon MTO participation, so it will be important to assess the feasibility of integrating a terminal appointment system with FRATIS through outreach to MTOs and ports in potential test communities.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Advent Port Community System	Modular port and terminal management system. One of the modules supports truck appointment systems. Others support drayage truck registries, truck tracking, community portals, clean truck programs, and traffic mitigation programs.	Customizable appointment system module can allocate time slots by time of day, day of week, and transaction type Can interface with TOS for increased efficiencies	N/A	Potential for integration with a FRATIS drayage optimization function, which could achieve additional queue reduction and air quality benefits Would require MTO and port participation

References

Gateway Cities Council of Governments, ITS Vendor Showcase, January 10-11, 2012.

6.2 Telvent Management and Information System for Ports

The Telvent Management and Information System for Ports (MISP) is an integrated IT solution designed to help ports manage vessel operations, including approach to the harbor, piloting, berthing, loading and unloading, and vessel departure. Ports use the system to coordinate activities amongst the diverse entities and actors operating within the port such as shipping agents, port security, stevedoring services, pilots, environmental services/waste collection, and safety officials. The system can be integrated with other port systems that already are in operation. It provides real-time system monitoring with the capability to set user-specified alarms and reports. The goal is to optimize a port's available resources to serve vessels efficiently, thus minimizing port administrative burdens and improving overall port efficiency. MISP is capable of pushing loading and unloading operations control data to truck and rail transportation firms, customs agents, and other interested parties. Although MISP is not specifically geared towards terminal appointments, the ship arrival and loading/unloading data it can provide could presumably support such a system.

Data and Communications

- MISP uses a "system-of-systems" approach which leverages existing data streams from MTOs, port security, pilotage services, and others to create a coordinated IT

package for port operations. It uses an open architecture which can integrate with preexisting port systems through data fusion.

Conclusions

MISP is not a terminal appointment system *per se*, but clearly the ship arrival, loading, and unloading information that it collects and disseminates could be useful for implementing such a system via FRATIS. This highlights the potential of better information sharing between ports and the trucking community in terms of leveling out truck flows and managing capacity both inside and outside the gates.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Telvent Management and Information System for Ports	Port management system focusing on coordination among port agents, entities, and port services on ships to manage ship arrival, unloading/loading, and departure	Coordinates portwide activities among many different actors Integrates with existing port systems Real-time system monitoring	Not specifically designed as a terminal appointment system	Potentially could be used to support an appointment system with vessel arrival data

References

Gateway Cities Council of Governments, ITS Vendor Showcase, January 10-11, 2012.

6.3 Port Metro Vancouver Container Terminal Scheduling System

Port Metro Vancouver, in response to labor unrest due to large trucking queue issues, and associated air quality concerns, implemented a truck reservation system in 2001 across its terminals for imports. This system, known as the Container Terminal Scheduling System (CTS), is designed to provide a given number of time slots during gate hours when a carrier who holds a valid permit with the Vancouver Port Authority can reserve and be assured of being admitted to the terminal to handle their container pickup. Reservations are given in hourly time slots. All trucks with reservations must be in line at least 15 minutes prior to the expiration of their reserved time slot. Trucking industry participation in this system is mandatory and penalties are in place for trucking companies who consistently miss appointments. This is a simple web-based reservation service that is deployed separately in slightly different configurations at all four terminals, with two of the systems based on extensions of their NAVIS terminal operations system, and two based on customized systems.

Anecdotal evidence suggests that the system has helped reduce truck queues and improve air quality, and stakeholder acceptance has grown over the years. However, web research also suggests that the trucking community is still dissatisfied in some ways with the current appointment system, particularly with its inability to accommodate delivery and pick-up of containers in one trip. Another

common complaint is that long queues sometimes cause a driver to miss an appointment, after which they are turned away because the appointment window has expired.

Data and Communications

- A reservation is made electronically through the terminal's web page against a time slot. Each time slot has a dedicated number of reservable transactions. These transactions are determined by the terminals and reflect the capacity that can be accommodated.

Conclusions

The Vancouver experience is one of the earlier implementations of a reservation system in North America and therefore experienced some growing pains. Carriers initially complained of increased administrative costs associated with booking appointments, difficulty in getting reservations and coordinating two-way trips, travel time uncertainty, and offsite queuing delays. It appears that some of these issues have yet to be resolved, notably the inability to schedule a two-way reservation allowing a truck to drop off an empty container or a laden container for export, then go pick up an import load in the same trip. This is important for FRATIS since such a constraint could severely limit the effectiveness of a drayage optimization strategy.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Port Metro Vancouver Container Terminal Scheduling System	Terminal reservation system at Port Metro Vancouver (British Columbia)	Mandatory for imports, which increases utilization of the system	Cannot accommodate two-way container movements in one window	Make sure that appointment systems work with drayage optimization strategies

References

Davies, P., "Container Terminal Reservation Systems," paper presented at the 3rd Annual METRANS National Urban Freight Conference, Long Beach, California, October 22, 2009.

Port Metro Vancouver, *Maintaining Ties: 2008 Annual Report*, available at http://portmetrovancouver.com/Libraries/ABOUT_Corporate/Port_Metro_Vancouver_2008_Annual_Report_English.sflb.ashx.

Port of Vancouver, "Container Terminal Scheduling System," memorandum dated March 1, 2001, available at http://www.portmetrovancouver.com/libraries/port_users_trucking/container_terminal_scheduling_systems.sflb.ashx.

Harbour Link Container Services, Inc., *The Growing Challenges of Port of Vancouver's Reservation System,* July 15, 2011, available at http://harbour-link.com/blog/2011-07-15/7-the-growing-challenges-of-port-of-vancouver-s-reservation-system.

6.4 Southampton, United Kingdom Truck Appointment System

At the Port of Southampton in the United Kingdom, yard congestion and high truck turn times due to rapid volume growth up to 2004 led to the implementation of a series of truck appointment systems. A voluntary Vehicle Booking System implemented in 2003 did not solve the problem; therefore in 2005 the port implemented a mandatory Simplified Vehicle Booking System after extensive outreach to the trucking community serving the port. The system features peak booking fees and no-show penalties, and provides for some level of booking flexibility through reservation amendments, multiple containers, changeable appointments, and the ability for drivers to amend reservations via cell phone or text message. There is a 24-hour helpdesk for the reservation system, and certain terminal modifications such as additional storage for empty containers also were provided. Stakeholder reactions to the program were generally positive due to the improvement in terminal turn times, although truckers noted the financial impacts of booking fees and no-show penalties. A key concern here was the lack of reciprocity: truckers view the no-show fees as a considerable expense they must bear if they miss a slot, but there is no corresponding charge to the terminal operator if they fail to deliver on maximum truck turn-time promises.

Data and Communications

- This is an Internet-based booking system for container pick-ups and drop-offs. Truck drivers and dispatchers make reservations through the web site. Booking details can be amended by cell phone, Internet, or text message as many times as needed, free of charge. When using the system, all details regarding a particular trip are recorded. Details of the containers to be dropped off or picked up, any special requirements, and the planned time of arrival are available prior to the truck's arrival at the terminal. A special system reference number associated with each reservation slot triggers the system to direct the driver to the best container transfer area. There is a 24-hour telephone helpdesk for booking problems.

Conclusions

The Southampton system's success stems in part from the outreach conducted prior to implementation. Although truckers still perceive some problems with the system, especially in terms of the lack of financial penalties for terminal operators if they cannot provide the promised turn times, overall the program has reduced port waiting times.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Southampton, United Kingdom Truck Appointment System	Terminal reservation system at the Port of Southampton (United Kingdom)	Provides truckers and dispatchers the ability to change appointments based on changing customer needs	Financial impacts on drayage firms of no-show penalties and booking fees No reciprocal penalties for terminals	Portwide systems require extensive outreach to the port trucking community

References

Davies, P., "Container Terminal Reservation Systems," paper presented at the 3rd Annual METRANS National Urban Freight Conference, Long Beach, California, October 22, 2009.

DP World Southampton, "Simplified VBS User Guide," available at http://www.dpworldsouthampton.com/portuserzone/simplifiedvbs/index.htm.

6.5 Long Beach Total Terminals International

In 2002, the California Legislature passed Assembly Bill 2650 (AB 2650), which provided a legislative incentive for the establishment of either reservation systems, or off-peak programs to shift container movements to off-peak hours. As a result many terminal operators established appointment systems voluntarily. Although the legislation led to a patchwork of systems (many of which turned out to be ineffective, and most all of which were superseded by the PierPass program), appointment systems at various terminals continued to evolve.

One notable example of this was Total Terminals International (TTI) at the Port of Long Beach. TTI implemented mandatory appointment scheduling for import pickups in 2007 and for export drop-offs in 2008. TTI uses a proprietary reservation system called VoyagerTrack. TTI advises truckers to book appointments at least 48 hours in advance. Truckers can cancel and rebook as necessary; there are no penalties for late arrivals or no-shows, nor are there any booking fees. Appointment windows are one hour with grace periods of 30 minutes before and up to 180 minutes after the hour.

By linking its reservation system to the terminal operating system, TTI could optimize container handling sequencing to minimize truck turn times. This resulted in a substantial efficiency improvement, with the terminal operator reporting three times the hourly transtainer[19] moves and turn times of less than 30 minutes with negligible queuing delays.

Data and Communications

- Truckers or dispatchers can make appointments on the terminal web site or by phone 24 hours per day. Users can recheck their preferred appointment time at the top of each hour when the system reallocates appointments, to see whether slots have opened up. The system is fully integrated with PierPass to coordinate off-peak moves.

Conclusions

The TTI appointment system appears to have been successful at improving truck turn times and reliability at the terminal, which are important factors for trucker acceptance of these systems. Flexibility to deal with changing business demands also is important for drayage truck firms. For FRATIS, this may mean that a thorough understanding of the characteristics of successful appointment systems should be a part of any assessment of potential test sites.

[19] Transtainer cranes are container yard cranes which work within terminal yards, stacking containers for storage and loading/unloading containers on trucks.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Long Beach Total Terminals International Appointment System	Terminal reservation system at Total Terminals International, Port of Long Beach	Mandatory for imports and exports, which increases utilization of the system	N/A	Study best practices in appointment systems to find out what characterizes successful ones

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Davies, P., "Container Terminal Reservation Systems," paper presented at the 3rd Annual METRANS National Urban Freight Conference, Long Beach, California, October 22, 2009.

Giuliano, G.; O'Brien, T.; Hayden, S.; and Dell'aquila, P., "The Terminal Gate Appointment System at the Ports of Los Angeles and Long Beach: An Assessment," METRANS Transportation Center, 2006.

6.6 Sydney Ports Vehicle Booking System

Two terminals under Sydney Ports (the New South Wales government entity charged with managing the State's ports) have had Vehicle Booking Systems in place since the 1990s. A history of conflict between terminal operators and the trucking industry led to the introduction of the appointment systems. However, there was continued friction between terminal operators and trucking companies, much of it driven by trucker perceptions that the existing system put undue burden on the trucking industry through the distribution of appointment slots, that the number of appointment issued was arbitrary and unpredictable, and that financial penalties were excessive and merely existed to create a new revenue stream for the MTOs. These complaints led to a major investigation for the New South Wales government by the Independent Pricing and Regulatory Tribunal (IPART), which had a broad mandate to find ways to improve landside port efficiency and assess the fairness of booking fees and no-show penalties, among other things.

With respect to appointment systems, the IPART investigation recommended the creation of a two-tiered vehicle booking system with "guaranteed" appointment slots allocated by auction, with the remainder allocated by the existing web-based method. However, this concept was regarded as unworkable by industry partners, and was therefore dropped in favor of an alternate arrangement in which Sydney Ports is leading the Port Botany Landside Improvement Strategy (PBLIS), which aims to improve the competitive access and overall efficiency of landside operations at Port Botany.

A key part of PBLIS is the mandatory Operational Performance Standards which both trucking firms and stevedores have to meet. There are reciprocal financial penalties for both parties in the event of noncompliance with the standards. The terminal appointment system is an important part of the compliance regime, as weekly performance indicators for both truckers and terminal operators are collected and published on the Sydney Ports web site. The weekly reports track truck turnaround times at both terminals against established performance requirements, as well as carrier- and stevedore-initiated cancellations and early/late arrivals on the part of truckers. Terminal operators retain overall control of appointment slots. The appointment program has been integrated with a peak-period charging policy which provides an incentive to shift container movements to less

congested times of the day. Truck turn-time and queuing data, which is used to evaluate MTO performance against the established standard, is verified through GPS or RFID truck tracking.

Data and Communications

- Like the other appointment systems profiled here, the Sydney systems use a common web portal where trucking firms can make appointments. Trucking companies and terminal operators have the option of modifying or canceling appointments as needed based on business conditions and customer requirements. Trucker and terminal performance measurement data are captured by Sydney Ports administration for use in performance tracking. Monitoring data are published on the Sydney Ports web site.

Conclusions

The PBLIS is unique in that MTOs are held financially accountable for meeting performance targets, in addition to the trucking companies which face financial penalties for noncompliance in most appointment schemes. Performance monitoring and publication by an independent third party (Sydney Ports Corporation) provides for transparency and openness for the settlement of disputes between trucking companies and terminals. To enable this performance monitoring function, the system has been fully integrated with truck queue detection and tracking systems as well as MTO systems. The program also is coordinated with a peak-period charging system to encourage the movement of freight during off-hours. This implies that the best solutions to truck queue and turn-time problems may involve a comprehensive package of operational improvements, of which technology is a key part.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Sydney Ports Vehicle Booking System	Terminal reservation system at Port Botany, Sydney, Australia	Reciprocal financial penalties for trucker and terminal noncompliance Integrated into comprehensive improvement package that includes peak-period charging Independent third party monitoring	N/A	Comprehensive queue management and terminal appointment strategies may achieve the greatest benefits

References

Davies, P., "Container Terminal Reservation Systems," paper presented at the 3rd Annual METRANS National Urban Freight Conference, Long Beach, California, October 22, 2009.

Sydney Ports Corporation, "PBLIS Guide: Regulation and Mandatory Standards Overview," Sydney Ports Corporation, March 2011.

Sydney Ports Corporation, "Weekly Web Performance Report 27 February-4 March, 2012," available at http://www.sydneyports.com.au/port_development/landside_improvement/performance_reports.

7.0 Public Sector Data Output – Performance Measures

Freight performance measurement is an important goal for transportation practitioners throughout the country. Freight operations impact a variety of issue areas, including air quality, congestion, and economic development. However, the data and tools required to develop and use meaningful freight performance indicators are frequently lacking. Transportation agencies often find it difficult to persuade private freight companies to participate meaningfully in the planning process, which firms tend to regard as overly lengthy and bureaucratic. Effective performance measurement often requires business-sensitive data that companies are reluctant to release, especially when they fear the result may be increased regulation. Although there are data collection methods that can obtain the necessary information (such as trip diaries and surveys), they tend to be expensive, putting them beyond the reach of some agencies.

In response to these obstacles, there have been ongoing efforts to quantify and measure freight performance metrics to support freight planning and project investment. Much research in recent years has involved the formation of public-private partnerships to collect, analyze, and disseminate data and performance measures using GPS positional data from commercial truck fleets. GPS records are precise, can be scrubbed to provide anonymity, and are comparatively low cost. They can be used to identify key freight bottlenecks and high truck traffic locations, allowing planners to target freight system capacity enhancements and scarce maintenance dollars.

Table 7-1 illustrates the state of the practice in this emerging area. Two recent projects – one at the national level and one in Washington State – have demonstrated the use of GPS records for freight performance measurement. The Iteris iPerform system, meanwhile, shows how multiple existing data streams can be aggregated and analyzed to measure transportation system performance in real-time – a function that could potentially be leveraged in a FRATIS performance monitoring capability that is specifically geared towards freight.

Table 7-1. Assessment of Public Sector Data Output – Performance Measures

Technology/ Program/ Project	Functional Area(s)	Description	Scope and Timeframe[a]	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
Private sector truck fleet GPS data sharing	Truck GPS tracking	Use of private truck GPS data for modeling and performance measurement	Medium 2002-Present (FHWA) 2008-Present (WA State)	Map truck bottlenecks/ problem areas Evaluate construction impacts on truck flows	Truck speeds Travel times	Privacy concerns No information about other items of interest such as commodity carried	Fleets providing data need to know confidentiality will be protected
Iteris iPerform Performance Measurement System	Performance monitoring	Real-time performance monitoring application for public sector transportation agencies	N/A Ongoing	Identify problem areas based on historical performance Evaluate impacts of weather, construction, and other factors on truck movements	Speed and travel time by freeway/ arterial segment Delays Demand on the network Safety performance	Ongoing cost to license/maintain	May be able to link to FRATIS for a public sector performance monitoring function if test bed region has access to a system like this

[a] Small – <$250,000; Medium – $250,000 to $1 million; Large – > $1 million.

7.1 Freight Performance Measurement using GPS

Two recent projects which developed freight performance metrics using GPS records are discussed herein.

University of Washington Truck GPS Study

Researchers at the University of Washington, in coordination with WSDOT, acquired and used third-party GPS data to track truck movements on the road network in the Puget Sound region. The researchers had previously tried approaching individual trucking companies for the data but this approach proved unworkable because of technical, financial, and confidentiality hurdles. They therefore turned to third party data sources (GPS providers), which made it possible to obtain data for multiple trucking fleets from only a few sources, thus limiting processing time and costs. Using this third-party data, UW was able to map the data to show, among other things, places where trucks have difficulty moving and various pre-, during, and post-construction project impacts on truck movement. The Washington State Legislature recently funded a statewide expansion of the data collection program.

FHWA Freight Performance Measures

At the national level, FHWA has sponsored the Freight Performance Measures (FPM) project. This project, led by the American Transportation Research Institute (ATRI, the research arm of the American Trucking Association, developed and tested a national system for monitoring freight performance on the nation's highways. The program includes FHWA sponsored studies of truck travel times in freight-significant corridors to measure the performance of the freight transportation system. Truck travel times indicate how well the intercity highway network is performing; data are being used to calibrate network assignment models and to understand activity by time of day. Performance measures include average truck speed by time of day, travel time, and reliability.

The project involves collection and scrubbing of GPS data and analysis of patterns and trends on major corridors around the U.S., Canada and Mexico. The data consists of GPS data from trucks (truck position records), scrubbed of individual company identity. The actual data is obtained from a variety of sources, including fleets, GPS vendors and telecommunication companies. ATRI prepares reports of data analysis and results, including derived performance measures for corridors and regions with congestion or delays. GPS data is collected in near real-time electronically from partners. Public updates are made regularly to FPMweb, which is a site administered by ATRI and sponsored by U.S. DOT to provide aggregated results from the FPM project such as travel speeds by three-mile corridor segments.

One key challenge associated with these projects is maintaining data confidentiality for the trucking industry partners who are providing the GPS data. In the FPM project, ATRI serves as a trusted third party data repository. Actual GPS unit positional data is not provided to the public, or to users contracting with ATRI such as the U.S. DOT and state DOTs. Rather, users obtain a license for "data products and services," so that performance measurement users may receive "dashboards" developed by ATRI which comply with the underlying agreements ATRI signs with data providers. The actual data is owned by the providers, who govern whether and how it can be shared. This certainly limits the real-time freight data available to agencies, however it is unlikely most carriers would agree to participate without these protections. In the University of Washington work, researchers had to sign

strict confidentiality agreements, and data are normally stripped of company identifying information prior to delivery.

Another challenge is the fact that GPS positional records do not address other freight data needs such as commodity carried.

Data and Communications

- In truck GPS data sharing, raw GPS location data is scrubbed to ensure anonymity and analyzed to develop average speeds by highway segment and other performance metrics.

Conclusions

The GPS data sharing efforts completed thus far have provided exceptionally rich sources of truck movement data which can be used for a variety of modeling and performance measurement applications. The confidentiality of sensitive business information must be protected, however. To the extent that the FRATIS application bundles involve data sharing with private entities, it will be important to craft agreements that deal effectively with these concerns. The forthcoming report from the NCFRP 31 project should offer useful guidance here.[20]

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Private Sector Truck Fleet GPS Data Sharing	Purchase of private truck GPS data for modeling and performance measurement	Rich source of truck movement data for performance monitoring and modeling	Privacy issues	Ensure appropriate confidentiality provisions in data sharing agreements with private sector

References

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[20] National Cooperative Freight Research Program, *NCFRP 31 Interim Report*, unpublished interim project report, October 2011.

7.2 Iteris Performance Monitoring

Iteris is a provider of traffic information management IT solutions to the public sector transportation management sector. The company provides traffic management engineering services, including performance measurement, as well as traveler information/511 systems. From a performance measurement perspective, Iteris is developing new software designed to "measure and manage" transportation networks. The firm's iPerform system is a decision support tool focused on transportation system performance monitoring. The data provided is intended for use in agency decision-making, including capital investments and operational planning. iPerform can perform sensitivity analysis (e.g., network impacts of lane closures, ramp metering, or other operational policies), and benefit/cost analysis of delay and congestion on the network. It also can provide network performance management metrics such as travel time and buffer time indexing,[21] real-time before and after analysis (e.g., from a construction project/capital investment), and system performance in inclement weather. Data are provided to users via a web-based dashboard display.

Data are gathered from multiple sources, including freeway/arterial traffic detectors, incident detection systems, weather sensors, and transit systems, collated into the iPerform engine, and used to generate dashboard reports. Archived data provides a detailed history of network performance and can be used to identify problem spots quickly. Based on historical data, the system can develop parameters for "normal" conditions by time of day, day of week, in different weather conditions, and for different modes. Data may be analyzed by 15-minute time increments. Users may create queries to perform sensitivity analyses of multiple scenarios. iPerform can be packaged together with a third party traffic flow data feed. Performance metrics can be broken down by freeway/arterial segment, and a mapping tool displays anomalies and existing operational conditions.

Data and Communications

- Data feeds from public sector ITS sensor networks, third party traffic data providers, transit systems, weather services, and others are combined in a proprietary engine for performance measurement of freeway and arterial speeds, travel times, and other metrics. Data are displayed in customizable dashboards via a web interface.

Conclusions

iPerform is an example of the sort of analytical tools that are now available to public sector transportation system managers based on aggregating and analyzing the growing body of data available for operational management and decision support. If a test bed region already utilizes iPerform, it may be possible to leverage it to support the public sector freight performance monitoring function of FRATIS.

[21] Buffer time is the additional time or time cushion due to congestion or other factors like special events that travelers must factor into their trip planning to ensure on-time arrival.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Iteris iPerform Performance Measurement System	Real-time performance monitoring application for public sector transportation agencies	Aggregates and analyzes multiple sources of real-time system performance data	Ongoing cost to maintain	May be a useful resource for the public sector performance monitoring function

References

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8.0 Container Load Matching

Drayage is defined as a short freight move that is completed as part of a longer overall move. Usually these moves relate to intermodal handoffs at ports and rail terminals, or to international border crossings to support in-bond manufacturing operations. As a result they are usually more or less transparent in the overall supply chain, even though they play a crucial role in it. Drayage operations are a primary cause of port-related truck congestion and air quality issues.

There are fleet and dispatch management technology solutions available for the intermodal drayage market, as shown in Table 8-1. Each dispatch software solution has a function that can send text messages to the driver's phone with container status, location, pickup number, and delivery instructions. This is good for drivers since they no longer have to write instructions down on a piece of paper, which can lead to errors. Also, each dispatch software solution can communicate data directly into a drayage firm's customer system. This means that when a driver indicates a load has been delivered through a text message or verbally, the drayage firm's system is updated so the dispatcher can assign the next move for that driver. The message can update the customer's system too, which reduces calls from the customer asking the status on delivery of the container and speeds up the billing process.

However, use of such systems varies widely by carrier. Drayage is a low-margin business, so many firms cannot afford to make significant IT investments. When a drayman does not have an automatic status/location feed (such as those provided by Profit Tools and Trinium), they have a data entry person visit the railroad or ocean line web site to copy and paste data, or they rely on e-mails received from the carrier or a third party to inform them of status and location of containers that need to be outgated. Often, changes in container status or location are not relayed to the drayman in time to avoid an unproductive trip. Many service providers still rely on manual "T-Card" dispatch systems, where dispatchers constantly rearrange paper cards representing work orders to assign assets throughout the day. This process is labor-intensive, can be error-prone, and often results in unproductive trips.

One thing that is apparent upon examination of Table 8-1 is that drayage optimization right now is almost exclusively a private sector endeavor. (Again, the notable exception is C-TIP, which is profiled in Section 2.) Moreover, public and private sector goals and concepts of drayage optimization may differ. The private sector may be more interested in improving billing processes and travel time reliability, compared to the public sector goal of bobtail reduction. This bears careful consideration during development of the Drayage Optimization application bundle.

Table 8-1. Assessment of Container Load Matching Systems

Technology/ Program/ Project	Functional Area(s)	Description	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
Profit Tools	Drayage Optimization	Dispatch and billing management software for smaller trucking firms	Reduces manual dispatch and billing processes; can trace container status on multiple rail web sites; can dispatch through mobile devices	Improved cash flow Better asset utilization Reduced human error	N/A	N/A
Trinium	Drayage Optimization	Enterprise software for mid- to large-size trucking firms	Reduces manual dispatch and billing processes; can trace container status on multiple rail/pier web sites; can dispatch through mobile devices	Improved cash flow Better asset utilization Reduced human error Improved driver/dispatcher ratio	N/A	N/A
RMI Vantage	Drayage Optimization	Intermodal terminal business intelligence tool	Real-time notification of changes and emerging issues at terminals; notifications when critical thresholds are reached	Improved operational efficiency	N/A	N/A
Loadmatch.com/ Drayage.com	Drayage Optimization	Loadmatch.com publishes empty container data posted by users for potential reloading Drayage.com is a directory listing of draymen who can outgate containers from a terminal	Subscribers get the opportunity to match loads that otherwise would go back empty; site can push load data onto client dispatch systems such as Profit Tools	Reduced empty backhauls Better asset utilization	N/A	N/A
NCFRP Truck Drayage Productivity Guide	Drayage Optimization	Guidebook for planners interested in improving the efficiency of port dray operations	Improves understanding of the causes, effects, and remedies for dray inefficiency	Reduced empty truck trips and emissions, improved terminal efficiency	N/A	Better information sharing can help reduce unproductive dray moves, but not every empty move can be eliminated

8.1 Private Sector Dray Software Packages

The prevalent software tools available to the drayage and intermodal terminal industry are profiled below. These packages feature options which can help carriers improve asset utilization by reducing unproductive trips and improving the driver-to-dispatcher ratio. There also are web sites dedicated to dray load matching which can interface directly with some of these software packages.

Profit Tools

Profit Tools provides a trucking software package targeted towards small- to mid-sized "flexible-service" carriers who typically do not have the same level of IT resources as larger carriers. The typical Profit Tools client has 10 to 50 drivers, and the firm is considered the leader in this market segment. A large segment of their market consists of intermodal drayage providers. Profit Tools software helps these carriers automate their billing, manage fuel surcharges and other fees, trace equipment on terminal and rail web sites, and improve load building and route planning. It also enables an electronic communication function between drivers and back office staff. The system can track container releases and pickup/delivery deadlines, helping the trucking firm eliminate missed appointments.

Dispatchers can assign loads and drivers by way of a drag-and-drop window. The interface allows for easy identification of reloads and backhauls, which improves asset utilization and reduces bobtail trips. The firm also offers a MobileDirect product, which provides for electronic dispatching through handheld devices and interfaces with common on-board mobile communications systems. These dispatch features largely eliminate a lot of the manual processes associated with dispatch, load planning, and billing, thereby reducing opportunities for human error and freeing up staff resources to do other things.

Profit Tools also is known for their Track and Trace module that pulls container tracing data off multiple railroad web sites and automatically populates the draymen's dispatch software. In this way, employees do not have to manually visit railroad web sites to obtain container location and status information.

Trinium

Trinium is another software provider which focuses exclusively on intermodal/multimodal trucking. Trinium's core market is medium- to large-size drayage firms, typically in the range of 50 to 200 drivers. Trinium's basic software package, the Transportation Management System, is a complete enterprise system for intermodal trucking operations which automates the entire process from order receipt to billing and driver settlements. This basic package comes with a variety of modules, including a Dispatch Module which helps rationalize the dispatch process and improve the driver-to-dispatcher ratio. To this basic package, customers can add several specialized modules depending on their needs. From a dispatch/drayage optimization perspective, two modules are key:

- Trinium Mobilecomm provides bidirectional communication between a driver's cell phone or handheld device and the Trinium Dispatch Module, so that dispatch instructions can be sent, received, acknowledged, and completed by the driver on his mobile device. This reduces time spent calling drivers manually to find out where they are and enables the same number of dispatchers to handle more drivers/orders.

- Trinium Availability Manager is similar to Profit Tools' Track and Trace feature. It enables Transportation Management System (or third party trucking systems) to interface with pier and rail web sites for tracking and tracing containers. When a container order is entered into the software, the track and trace process is completely automated, reducing the manual effort involved with managing notifications, calculating ETAs, and monitoring box availability and last free day over multiple web sites.

The software can interface directly with mileage software such as PC*Miler and Rand McNally, as well as fuel management service providers and mobile communications platforms.

RMI Vantage

RMI is a provider of software to transportation providers, specializing in the rail market. The firm's Vantage software is a real-time business intelligence tool that provides users immediate visibility of change. It is designed specifically for intermodal operations providing the capability to monitor, measure, and manage certain key intermodal performance metrics. Vantage currently is deployed at 80 plus intermodal terminals in North America and is widely accepted as an industry standard.

Vantage uses graphical dashboard views, reports and alerts to give users dynamic information about terminal operations. Users can set critical warning thresholds with automatic notification when they are reached, allowing terminal managers to respond to issues in real-time. Alerts can be sent to desktop computers via e-mail or to mobile devices. Query results and dashboards also may be transmitted to external customers and vendors. Dashboards and performance metrics can be developed using a drag-and-drop interface, without the need for programming or IT staff.

Loadmatch.com/Drayage.com

Loadmatch.com and Drayage.com are two web sites (run by the same company) which provide load matching services to the intermodal trucking community. Loadmatch.com provides information to connect buyers and sellers of intermodal transportation services to help them improve equipment utilization by exchanging information on loads, trucks, and equipment. The site pulls together capacity information (truck power with empty equipment, trucking power only, and empty equipment without truck power) and matches it to available loads. Members pay a flat monthly subscription fee to use the service.

Members benefit by posting and receiving information not made available through public access. A drayman can run a report of all their inbound containers scheduled for delivery and do internal matching of containers to be delivered to loads that need to be picked up. Containers that cannot be matched up internally and will come back empty are published on LoadMatch.com so outside users can see what is available for reloading. LoadMatch.com is able to push this data on containers available for reload into client computer systems such as Profit Tools, or people can just visit the web site to see what is available.

Not every container will be reloadable, for a variety of reasons:

- The most common cause for containers not being reloaded is the ocean line enforces a mandatory terminate empty policy. Sometimes the ocean line urgently

needs to reposition empty containers into higher demand areas, or the ocean line wants a preferred drayman to get possession of the empty containers.

- Some containers are "lease" boxes, meaning the ocean line is leasing the container, and once empty a lease box needs to be terminated empty because the leasing company does not know what ocean line is going to lease that specific container next.
- Some containers are damaged en route and therefore need to be fixed before being reloaded.
- Some containers carry smelly or messy cargo and cannot be reloaded until the inside of the container is cleaned.

Drayage.com is different from Loadmatch.com because not every container is an export load. Every container eventually needs to be outgated from a terminal, but this has nothing to do with matching up an empty container on the street.

To solve that need, Drayage.com is a web site that lists the draymen that serve the terminal and are potentially able to outgate a container. Drayage.com is a phonebook-like directory of draymen, with very detailed profiles on each one. The profiles provide detail such as which draymen have private chassis, which can move hazmat containers, which have TWIC drivers to serve the port terminals, and how far each drayman will run a container (e.g., the states/provinces they serve or radius from terminal). There currently are 1,780 drayage terminals listed in the Drayage Directory.

Data and Communications

- Trucking software enables on-line dispatch with "push" message capability to inform drivers of new loads. Software can interface with third party web sites to automatically collect shipment and container availability information from pier and rail terminals.
- Vantage monitors key intermodal terminal performance metrics using data feeds provided by clients.
- Loadmatch.com posts capacity (truck and equipment) and demand (available loads) data gathered from multiple client sources to enable clients to better match loads and improve asset utilization. The site also can push container availability data out to client dispatch platforms.

Conclusions

The table below describes each of these technologies and their potential relationship to FRATIS. Overall it is clear that the market has developed technology solutions for the drayage industry which can help operators reduce bobtails and improve other business processes such as billing. However, many operators are small and do not necessarily have the resources to invest in expensive IT solutions. There also are some practical reasons why not all loads will be matched, such as terminate empty policies enforced by steamship lines. Draymen do not always have control over these external factors. For FRATIS, it is important to understand the particular conditions under which loads can be matched to develop targeted applications to facilitate the process.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Profit Tools	Dispatch and billing management software for smaller trucking firms	Track and Trace module automatically pulls container data from rail web sites	N/A	Software solutions for this problem exist but not all operators can afford sophisticated IT systems
Trinium	Enterprise software for mid- to large-size trucking firms	Availability Manager similar to Profit Tools Track and Trace	N/A	
RMI Vantage	Intermodal terminal business intelligence tool	Real-time monitoring with graphical dashboards	N/A	
Loadmatch.com/ Drayage.com	Loadmatch.com publishes empty container data posted by users for potential reloading Drayage.com is a directory listing of draymen who can outgate containers from a terminal	Can push container availability updates on to clients' computer systems such as Profit Tools	N/A	There are practical and institutional obstacles to matching intermodal containers, not all of which are under the control of draymen

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http://www.loadmatch.com/.

http://www.drayage.com/.

8.2 NCFRP Truck Drayage Productivity Guide

The National Cooperative Freight Research Program (NCFRP) recently released a guidebook aimed at helping planners understand the causes of bottlenecks, delays, and extra trips in the port drayage industry, and develop policies to reduce these problems.[22]

There are a lot of reasons for drayage delays, not all of which can be addressed by technology. Examples include RPM radiation detectors, equipment problems, and exceptions at the port gates

[22] Transportation Research Board, *NCFRP Report 11: Truck Drayage Productivity Guide*, 2011.

creating disruptions. Peaking activity around vessel arrivals can create significant delay at the port gates. Marine terminal labor issues and slow legacy systems also can contribute to long turn times. Most trouble tickets are related to process, information, and dispatch problems rather than equipment condition or security issues. Marine terminals' number one priority is usually unloading a vessel, which means that drayage efficiency often receives short shrift. Delays are more common in the in-gate transaction because the out-gate process is usually much simpler.

Before and after time series or with and without data are required to evaluate solutions to drayage bottlenecks. In designing a policy or technology solution, planners need to understand the priorities of drayage drivers. Drivers' motivations can vary based on compensation method. Drayage drivers are typically paid on a piecework basis (per load) – meaning the number of loads they can move in a day determines their pay.

"Street turns" (reusing an empty import container for an export load) can reduce drayage trips but there are major institutional and information barriers to doing this. This is because the port drayage process is mostly driven by the requirements of steamship lines and their customers (shippers), and it is a complex process involving many more stakeholders, including 3PLs, trucking firms, and terminal operators. Terminal operators typically respond to the needs of ocean carriers, while drayage firms must answer to shippers. Overall however, drayage carriers have very little control over the process. As noted above, ocean carriers frequently require boxes to be brought back empty, thus negating the ability of the drayage firm to match a backhaul load even if one was available.

Unproductive dray trips occur for many reasons:

- 'Dry runs' result when a driver goes to the marine terminal but is unable to complete the assignment. These often result from lack of information, for instance when a driver arrives to pick up a load before it has been released by Customs and/or the terminal operator.
- Extra empty equipment moves are required to balance intermodal assets and get the right equipment to where it will be most useful.
- Recent changes made to the Uniform Intermodal Interchange Agreement (UIIA) allow equipment to be returned to a different place than where it was picked up.[23] Although this change is a result of better communication and information flows between intermodal parties, it can often lead to extra dry runs when a motor carrier is not notified of changes in empty return instructions in a timely manner. This is especially problematic since many drayage firms create a dispatch plan and communicate it to their drivers the night before, thus increasing the likelihood that changes made after the dispatch plan was developed will result in dry runs.
- Congestion, clean trucks requirements, and security mandates often generate motor carrier shuttle operations and "dray offs" where motor carriers with terminals near the port make shuttle trips between the port and their own facilities. This breaks what would have been one trip into two, but it may be the most efficient way for motor carriers to handle these transactions.

[23] The UIIA is maintained by the Intermodal Association of North America. It governs how intermodal firms transfer custody of equipment.

The study concluded that better information sharing between motor carriers and marine terminals could reduce unproductive dray trips. For example, more consistent empty return instructions would help dray dispatchers plan their business more effectively. Advance warning of changes in gate hours, functional restrictions within the gates (e.g., restricted areas when a vessel is being worked), and other such constraints could be proactively reflected in dispatch plans, thus reducing dry runs and inordinate delays for dray truckers.

Data and Communications

- Not applicable.

Conclusions

This NCFRP report concisely summarizes all of the key causes of dray truck inefficiency in port operations. It also points out where information gaps could be contributing to unproductive moves. As such it is an important resource for FRATIS moving forward since it describes typical situations where the elimination of a bobtail or other unproductive trip might be eliminated through better use of technology.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
NCFRP Truck Drayage Productivity Guide	Guidebook for planners interested in improving the efficiency of port dray operations	Encapsulates all of the major causes of dray inefficiency in one report	N/A	There may be opportunities to reduce dry runs and other unproductive activity through better information sharing but this would require cooperation from multiple stakeholders

References

Transportation Research Board, *NCFRP Report 11: Truck Drayage Productivity Guide*, 2011.

The Tioga Group/Center for Transportation Research, UT-Austin/University of South Carolina, "Truck Drayage Practices," webinar presented November 17, 2011.

9.0 Transformative Goals and Performance Measures for FRATIS

This section describes the proposed transformative goals, performance metrics, and performance targets for FRATIS. These goals and performance measures are based on the results of this state-of-the-practice scan, additional Internet research, and the collective experience of the consultant team. The performance targets are provided in three timeframes: near term, corresponding to the next 5 years; midterm, which is 5-10 years out; and long-term, which is more than 10 years.

Note that initial FRATIS deployments will be regional and focused on areas with significant freight congestion, such as that found around major ports, large cities with significant distribution and warehousing activity, or busy land border crossings. Since these are the regions where the largest benefits are anticipated, the performance measures and goals may change as additional regions are added.

Table 9-1 lists these initial goals, performance metrics, and performance targets for FRATIS. For improvements in travel time, reduced fuel consumption, and reduced emissions, the increasing benefit over time is assumed to result from incremental improvements in technology and user interfaces within fleets that adopt FRATIS, regardless of overall market penetration (i.e., the improvements are expected for the adopting fleet irrespective of the level of FRATIS usage in the wider population of trucks). Bobtail reduction metrics are predicated on full coordination between participating truck fleets and terminal operators, since without such coordination it becomes much harder to reduce unproductive truck trips. Finally, for reductions in terminal queue times, the incremental improvements over time assume improvements in queue detection systems as well as growing adoption of new methods of information delivery such as smartphones.

Table 9-1. Summary of Initial FRATIS Goals, Performance Measures, and Performance Targets

Goal	Performance Measure	Transformative Performance Target (Near-, Mid-, or Long-Term)	Predominant Benefit(s)	User-/System-Orientation	Source
Improve travel time	Travel time	15% travel time reduction (near) 17.5% travel time reduction (mid) 20% travel time reduction (long)	Mobility	System-/User-oriented	C-TIP
Reduce fuel consumption	Fuel consumption	5% reduction in fuel use (near) 10% reduction in fuel use (mid) 15% reduction in fuel use (long)	Energy	System-/User-oriented	C-TIP
Reduce emissions	Level of criteria pollutants and greenhouse gas equivalents	5% reduction in criteria pollutants (near) 10% reduction in criteria pollutants (mid) 15% reduction in criteria pollutants (long) 5% reduction in GHG equivalents (near) 10% reduction in GHG equivalents (mid) 15% reduction in GHG equivalents (long)	Environment	System-/User-oriented	C-TIP
Reduce bobtail trips	Number of bobtail trips	10% reduction in bobtail trips (near) 15% reduction in bobtail trips (mid) 20 % reduction in bobtail trips (long)	Efficiency	System-/User-oriented	C-TIP
Reduce terminal wait times outside the gates	Terminal queue time	20% reduction in terminal queue times (near) 35% reduction in terminal queue times (mid) 50% reduction in terminal queue times (long)	Efficiency	User-oriented	FIRST Evaluation
Improve truck trip safety	Number of freight-involved incidents (e.g., bridge strikes)	30% reduction in freight incidents (near) 35% reduction in freight incidents (mid) 40% reduction in freight incidents (long)	Safety	System-/User-oriented	ITS Benefits: Continuing Successes and Operational Test Results

APPENDIX A. Other Research and Projects

This appendix contains data on freight data and ITS projects that have less direct relevance to FRATIS but do provide useful background. They primarily fall under the following categories:

- Prior U.S. DOT studies and projects which have informed the state of the practice but are now dated;
- Programs revolving around security (e.g., Hazmat truck tracking);
- Funding programs which can be used for freight ITS projects; and
- Current work in the Euro zone countries.

Table A-1 lists these efforts and their key lessons learned. The following subsections provide summaries of each project with data and communication protocols and lessons for FRATIS

Table A-2. Other Research and Projects

Technology/ Program/Project	Functional Area(s)	Description	Scope and Timeframe[a]	Benefits and Impacts	Performance Measures	Issues	Lessons Learned
IFTWG Asset Tracking and Freight Information Highway	Truck GPS tracking	Tested an intermodal asset tracking device combined with web-based logistics application	Medium 2001-2003	Up to $264 million annual financial benefit	Shipment visibility Reduced data entry delay	There were some initial data reporting errors with the chassis tracking devices	First system that could integrate shipment data from multiple sources and formats; led directly to development of EFM program
FIRST Port Info System	Port/ intermodal terminal information web portal	PANYNJ port information web portal	Medium Completed in 2003	Up to $50,000 per day savings for trucking industry	Reduced queue times Better visibility of vessel schedules, container/chassis availability	Never achieved high level of use Lacked a terminal appointment system	Ocean carriers and terminal operators typically have their own such web sites for customers and do not want to send data to multiple systems
HazMat Truck Tracking	Truck GPS tracking	Pilot test to determine feasibility of a hazmat truck tracking center	Large Ongoing	Complete visibility of hazmat shipments for environmental and security agencies	Better visibility of hazmat shipments Real-time risk assessment and accident response	None identified in the pilot	A project to build a functional prototype tracking center is underway in Kentucky, so there are no lessons learned yet
Truck Parking Facilities Grant Program	Truck parking	SAFETEA-LU program to address the shortage of truck parking on the National Highway System	Varies Ongoing	Funds can be used for ITS projects	Improved collection and dissemination of truck parking capacity data	Agencies applying for ITS funds must compete with other projects, including new parking infrastructure	Monitor for new funding opportunities
SMARTFREIGHT	Freight traffic management	Better coordination between traffic operations and freight distribution systems to make urban goods movement more efficient, green, and safe	Large 2008-2011	Ability to monitor the volume and duration of stay of trucks within the region, enforcement support Firms benefit from real-time traffic and construction data	Reduced urban area congestion and pollution	There is a lot of “noise” in the available data; systems need to be able to filter this out	
EURIDICE	Freight information exchange	“Intelligent cargo” concept using RFID tags connected to mobile communications and servers to generate real-time cargo updates	Large 2008-2011	Real-time reporting of many parameters, including temperature, position, and ETA	Better shipment visibility Improved economic competitiveness	Expensive; unclear whether wide adoption has resulted	The EU has made significant advances in freight information exchange and using mobile technology to improve supply chains, however the scope of this effort seems to be beyond what has been contemplated in the U.S. thus far
e-Freight	Freight information exchange	EU framework for efficient exchange of freight data between firms and regulators, and among EU nations	Large 2010-Present	Developed a “single window” for regulatory reporting at the national level	Better shipment visibility More efficient freight flows between EU member states	N/A; testing is ongoing	

[a] Small – <$250,000; Medium – $250,000 to $1 million; Large – > $1 million.

IFTWG Asset Tracking and Freight Information Highway

The Intermodal Freight Technology Working Group (IFTWG) has sponsored research and test demonstrations of freight information sharing and cargo visibility systems. One test involved the test deployment of an intermodal asset tracking technology integrated with a web-based freight logistics application to provide end-to-end shipment visibility. Each of these components was initially developed by private sector entities through a cost-sharing arrangement between U.S. DOT and American President Lines.

A chassis tracking system called Cargo*Mate was developed by PAR Logistics Management Systems. It included a "DataGate" unit that attaches to intermodal chassis and can report GPS location, chassis status, covered/bare status, and unit battery level. These data were available through a web interface linked to a customized logistics software application called the Freight Information Highway (FIH), which was developed by Transcentric (the IT arm of Union Pacific Corporation). The Freight Information Highway was an open source XML schema designed to help public and private entities share freight data. The system was thus able to provide an asset tracking capability that previously had been lacking in the industry. A test deployment in Memphis, Tennessee validated the concept (a similar test in Oakland was limited by various technical problems with the hardware). The evaluation concluded that Cargo*Mate could be expected to eliminate existing gaps in cargo visibility, as well as data entry delay (which is sometimes more than four days). Annual benefits associated with these improvements were estimated at $160 million for FIH (based on about 13.6 million shipments per year) and $52 million to $104 million for Cargo*Mate (based on deployment on 750,000 domestic chassis).[24]

The FIH was the first application providing the ability to capture and standardize intermodal freight shipping and tracking data from multiple sources and in multiple formats. Having successfully proved this concept, it was a major driver in the later development of the Electronic Freight Management Program, which is profiled in Section 3.1. In fact, the FIH architecture was used to form the basic information architecture for EFM.

The FIH work described above is complete; ongoing efforts have been subsumed under the Electronic Freight Management program, which is described later in this report.

Data and Communications

- GPS unit on chassis tracks location and status of intermodal equipment and transmits to a web interface via open source XML schema.

Conclusions

The table below summarizes the strengths and weaknesses of this project, and its implications for the FRATIS. Overall the Asset Tracking/FIH work successfully demonstrated the supply chain visibility benefits associated with better visibility of intermodal assets. The difficulties encountered with the

[24] U.S. Department of Transportation, *Intermodal Freight Technology Working Group Asset Tracking and "Freight Information Highway" Field Operational Test Evaluation: Final Report – Executive Summary*, September 2003.

Cargo*Mate devices suggest care should be taken in choosing any particular hardware to be used in a FRATIS application; however it seems likely that most if not all of the technical issues associated with this test have been overcome.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
IFTWG Asset Tracking and Freight Information Highway	Tested an intermodal asset tracking device combined with web-based logistics application	Demonstrated ability to integrate various data into useful information	Problems with asset tracking hardware limited the scope of the test	Hardware used in FRATIS application bundles should consist of proven technologies

References

U.S. Department of Transportation, *Intermodal Freight Technology Working Group Asset Tracking and Freight Information Highway Field Operational Test Evaluation: Final Report – Executive Summary*, September 2003, available at http://ntl.bts.gov/lib/jpodocs/repts_te/13950.html.

FIRST Port Info System

The Freight Information Real-Time System for Transport (FIRST) at the Port Authority of New York and New Jersey is an IT effort attempting to solve multiple problems related to land and facility expansion limitations at the port. It is an Internet-based, real-time network that integrates sources of freight information in a single Web portal, including container status, chassis status, vessel schedules, web cameras, and port traffic conditions. There are over 500 registered users of the system, representing more than 300 companies doing business at the port.

Although FIRST worked as intended, factors limited its adoption and use by the PANYNJ freight industry:

- FIRST was unable to capture a critical mass of users which might have engendered wider participation;
- Ocean carriers and terminal operators have their own web sites for their customers and will not send data to two places unless convinced of the benefits; and
- Significant benefits for industry will not occur without a terminal appointment system.

Notwithstanding these limitations, other port community systems have successful characteristics and features that could be applied to FIRST, including the Pacific Gateway Portal Truck Appointment System and the eModal capability to pay demurrage and other cargo fees on-line. A modeling evaluation of a FIRST appointment system for trucks estimated potential trucking industry queuing time savings of up to 37,947 minutes per day across all vehicles calling at the terminal. Air quality improvements of nearly $1 million annually (in 2003 dollars) also could be achieved through

reductions in truck idling at terminal gates, assuming 10 terminals in the region of similar size to the one analyzed adopted the system.[25]

The FIRST web portal is still operational despite the challenges discussed above, but is not clear whether its functionality extends beyond vessel call information and coordinating billing adjustments with the Port Authority. There are no indications that a terminal appointment system was ever incorporated into FIRST.

Data and Communications

- Web portal integrates data feeds from carriers, terminal operators, the port, Customs, and ITS resources to provide real-time operational data to users.

Conclusions

FIRST was an interesting demonstration of an Internet-based data integration capability, however it did run into some obstacles related to partner data sharing. The reason for the lack of participation on the part of some stakeholders was they were not convinced of the benefit they might accrue. It is important to ensure that partners realize a benefit that outweighs any cost they may incur by participating in such a program.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
FIRST Port Info System	PANYNJ port information web portal	Integrates various sources of shipment info into a single web portal	Never achieved "critical mass" of users due to data gaps	All stakeholders need to be convinced of benefits to participate

References

U.S. DOT, *Freight Information Real-Time System for Transport (FIRST): Evaluation Final Report*, October 2003, available at http://ntl.bts.gov/lib/jpodocs/repts_te/13951/13951.pdf.

U.S. DOT, "Freight Information Real-Time System for Transport (FIRST)," *Freight News*, March 2002.

HazMat Truck Tracking

A 2004 U.S. Federal Motor Carrier Safety Administration (FMCSA) study concluded that smart-truck technology (such as GPS tracking, wireless modems, panic buttons, and on-board computers) will be highly effective in protecting hazmat shipments from terrorists and produce a huge security benefit and an overwhelmingly positive return on investment for hazmat carriers. The test evaluated several technologies, including on-board computers, wireless and wired panic buttons, biometric

[25] U.S. DOT, *Freight Information Real-Time System for Transport (FIRST): Evaluation Final Report*, October 2003.

authentication, satellite communications, and electronic cargo seals. Tests were conducted in several hazmat truck market segments:

- Bulk fuel delivery;
- Less-than-truckload (LTL) high-hazard shipments;
- Bulk chemicals; and
- Truckload explosives.

Evaluation was conducted through benefit/cost analysis, surveys of motor carriers, and qualitative investigation, including interviews and a Delphi analysis. Overall the analysis showed positive benefit/cost ratios in all three areas of security, safety, and freight efficiency, ranging from 1.4:1 for the LTL market to 96.9:1 for the truckload explosives area.[26] The basic enabling technology (wireless communications with GPS positioning) was found to have the potential to enhance motor carrier efficiency and demonstrate sufficient payback for the private sector to adopt it on its own (which has since happened to a large extent). However, other technologies building on the core technology suite were likely to require government intervention to achieve significant market penetration. Policy options to encourage this include financial incentives to encourage technology investment, additional research and development efforts, ensuring data privacy for carriers, industry outreach, and performance-based rulemaking to allow carriers flexibility in meeting new requirements.

The FMCSA study led to the U.S. Transportation Security Administration's (TSA) Hazmat Truck Security Pilot. This congressionally mandated pilot program was undertaken to demonstrate if a hazmat truck tracking center was feasible from a technology and systems perspective and to determine if existing truck tracking systems can interface with government intelligence centers and first responders. The pilot proved that a hazmat truck tracking center is technically feasible and that smart-truck technology can be crafted into an effective and efficient system for tracking hazmat shipments. The study found that any future full scale system would need to consider additional factors, including:

- Easily capturing and transmitting manifest and trip initiation information;
- Tracking cargo versus trucks;
- Advanced technologies for disabling rogue vehicles;
- Improved system response time; and
- Outreach and training for first responders, carriers, shippers, and technology providers.

In 2007, the Kentucky Transportation Center (KTC) of the University of Kentucky led a project funded by DHS to evaluate TSA and EPA needs. The project, which was completed in 2008, was designed to assess the feasibility of establishing the North American Transportation Security Center in Kentucky.

The Transportation Security Center, as envisioned by the KTC project team, will serve as the implementing tool for a model hazmat regulatory program in Kentucky that will require:

[26] U.S. DOT, *Hazardous Materials Safety and Security Technology Field Operational Test Volume I: Evaluation Final Report Executive Summary*, November 2004.

- High-risk hazmat transporters to install "smart truck" technology on their vehicles;
- Shippers and carriers to send electronic manifests and electronic route plans to the Transportation Security Center;
- Carriers to report vehicle location and alerts to the Transportation Security Center (real-time XML data feed); and
- Companies to pay hazmat regulatory fees.[27]

This project will most likely be modeled after Singapore's Hazmat Transport Vehicle Tracking System (HVTS).

- A "smart truck" equipped with an on-board computer, GPS receiver, and a wireless modem will use an Internet connection (satellite or cellular) to interact with the Transportation Security Center and a commercial fleet tracking data center.
- E-manifest transactions between the carrier and the Transportation Security Center will provide the Transportation Security Center with information on the types and quantities of materials the transporter is hauling as well as shipment status (i.e., awaiting pickup, in transit, etc.).
- Data from the carrier's fleet tracking data center will provide the Transportation Security Center the carrier's exact location at all times. The shipper and/or carrier also will submit route plans. Alerts from the shipper or carrier will be generated when different events occur.
- The Transportation Security Center will merge e-manifest, vehicle location, route and alert data to provide government officials real-time visibility into the security status of hazmat shipments. In the event of a security incident, the Transportation Security Center will interact with State and Federal operations centers.

As a follow-on project, the University of Kentucky received a $3.5 million grant in 2008 to design a functional prototype of a hazmat truck tracking center. The project complements the Congressional mandate for TSA to develop a tracking capability for security-sensitive materials. This work began in late 2008 through the National Institute for Hometown Security and is ongoing. The exact technologies to be utilized are not known at this time but will likely include some combination of GPS tracking, wireless modems, panic buttons, and on-board computers to improve hazmat shipment security. The KTC and the University of Kentucky hope to leverage this project into a multistate implementation program to bring the hazmat truck tracking center into full operational status.

Data and Communications

- Hazmat center would receive real-time data from carriers using "smart truck" technology, including vehicle location and exception reports.
- Location data integrated with manifests and route plans to provide real-time visibility into hazmat shipments.

[27] University of Kentucky, Kentucky Transportation Center, *The North American Transportation Security Center*, December 2008.

Conclusions

Since the terror attacks of September 2001, there has been continuing interest in ensuring the security of hazmat shipments, which under lax security protocols can be attractive targets for terrorists. Hazmat truck tracking is technically feasible; the remaining obstacles appear to revolve around making key regulatory changes that would enable more robust procedures, and securing the funding necessary to implement tracking centers. Hazmat tracking may need to be a part of the FRATIS application bundles given ongoing security imperatives.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
HazMat Truck Tracking	Pilot test to determine feasibility of a hazmat truck tracking center	Proved that hazmat tracking is technically feasible	Will require regulatory action to fully implement	FRATIS developers should monitor progress of the functional prototype hazmat tracking center in Kentucky (an ongoing project)

References

U.S. DOT, *Volume I: Evaluation Final Report Executive Summary*, November 2004, available at http://www.fmcsa.dot.gov/safety-security/hazmat/fot/hm-vol1.htm.

U.S. DOT, *Hazardous Materials Safety and Security Technology Field Operational Test Volume II: Evaluation Final Report Synthesis*, November 2004, available at http://www.fmcsa.dot.gov/safety-security/hazmat/fot/hm-vol2.htm.

University of Kentucky, Kentucky Transportation Center, *The North American Transportation Security Center*, December 2008, available at http://www.serri.org/publications/Documents/UK%20ITTIS%20Project%20Final%20Report%20(Crabtree%20-%2018%20Dec%202008).pdf.

Truck Parking Facilities Grant Program

The Truck Parking Facilities Grant Program was established to address the shortage of long-term truck parking on the National Highway System. Under SAFETEA-LU, this program was authorized for $6.25 million per year through 2009. Preference is given to projects that provide substantial benefits in terms of congestion relief or highway safety. Eligible projects include those that promote the real-time dissemination of publicly or privately provided commercial motor vehicle parking availability on the NHS using ITS and other means. Although SAFETEA-LU expired in 2009, this program has been funded since then through a series of extensions.

Data and Communications

- Not applicable; this is a funding program which can be used for ITS projects dealing with truck parking.

Conclusions

The Truck Parking and Facilities Grant program may represent an attractive source of funding for ITS demonstrations that deal with truck parking. However funding is uncertain since ITS projects must compete with several other types of projects (including new capacity) for limited funds. Moreover, the future direction of this program is uncertain given the debate over SAFETEA-LU reauthorization.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
Truck Parking Facilities Grant Program	SAFETEA-LU program to address the shortage of truck parking on the National Highway System	Funds can be used for ITS projects	Agencies applying for ITS funds must compete with other projects, including new parking infrastructure	Possible source of funding for a demonstration project

References

U.S. DOT, "Truck Parking Facilities Program Discretionary Grants for FY 2012," available at http://www.fhwa.dot.gov/discretionary/tpi2012selc.htm.

International Research and Projects

Several freight ITS and information exchange projects in Europe have been completed under the auspices of the European Union which may offer useful lessons for FRATIS. Most of this work revolves around improving the penetration of advanced technology applications in logistics-oriented businesses, especially those that may lack the resources to employ such solutions on their own. Some examples of recent work are profiled herein.

SMARTFREIGHT

The purpose of SMARTFREIGHT is to specify, implement and evaluate Information and Communication Technology (ICT) solutions that integrate urban traffic management systems with the management of freight and logistics in urban areas. The effort involves integrating technology based data, traffic management data, and freight distribution/logistics data together with bidirectional wireless communication between a traffic control center and individual freight vehicles. The actual transport operations carried out by the freight distribution vehicles are controlled and supported by means of wireless communication infrastructure and on-board and on-cargo equipment. A range of public and private partners participated in the project, with overall coordination provided by SINTEF in Norway.

For cities, the main advantages of having an electronic data sharing system like SMARTFREIGHT would be the monitoring of the number of freight vehicles entering the city and the time they stay (helping them to solve congestion issues), follow-up of dangerous goods vehicles and enforcement support. The urban traffic management data that freight operators could uses benefit from includes information such as total trips time and construction information and dynamic information such as real-time traffic data. Systems that can filter out unwanted information are desired. Standardized interfaces and harmonized communications are important for sharing of technical freight data. SMARTFREIGHT was funded by the European Commission at around three million Euros.

European Interdisciplinary Research on Intelligent Cargo for Efficient, Safe, and Environmentally Friendly Logistics (EURIDICE)

EURIDICE is centered on the concept of "intelligent cargo" capable of self-identification, position reporting, status monitoring (e.g., temperature), and providing appropriate shipment information to key stakeholders, including the carrier, customs authorities, and cargo owner. The idea is to reduce the errors associated with manual data entry, provide asset utilization data in real-time to facilitate better load planning, and provide accurate times of arrival so planners can schedule outbound loads better. All of this is accomplished through the use of an RFID chip embedded in the cargo. For scalability, the RFID tags can be attached to individual parcels, pallets, or containers. The chip interacts with barcode scanners and other identification technologies and receives information on position, traffic, weather, and route changes, which the "intelligent cargo" (IC) software uses to calculate time of arrival. Significant changes are reported automatically to interested parties through GSM cellular, GPS, or other technologies. Upon delivery, the software identifies off-loaded items and sends proof of delivery to the consignor and other interested parties.

For shippers and cargo owners, benefits include better shipment visibility, real-time estimates of arrival time, and the ability to plan for delays or incorrect shipments before the freight arrives on the dock. Carriers can benefit through a reduction in human error resulting from manual information entry and improved asset utilization from better visibility of trailer capacity. Customer service also is improved by better shipment visibility. Finally, intelligent cargo can benefit customs authorities and other agencies by expediting procedures like payments, customs clearance, and security checks; limiting delays or disruptions by improving the billing system; and providing real-time updates on cargo status.

EURIDICE is probably the most ambitious program of its type in Europe, with funding of about 14 million Euros, over 8 million of which was provided by the European Commission with the rest presumably coming from participating national governments and industry partners. The project ended in October 2011; it is not clear whether any aspects of it have continued since then. However according to the project web site, EURIDICE "has built a platform enabling cargo items to interact with systems and users along the logistic chain, and has shown through various industrial demonstrators how this enables faster, more efficient and environment-friendly freight transport."[28]

e-Freight

e-Freight began in January 2010 and involves 30 government, industry, and research partners from 14 EU member states plus Norway. It is a four-year project aiming to build a framework for the exchange of freight data between government and private sector firms within the EU. e-Freight capabilities are to be developed to support four key stakeholder groups:

- Transport users, to identify and use the best combination of freight modes for their needs;
- Carriers from all modes, to provide information about their services and exchange data electronically with other relevant parties throughout the supply chain and to set up optimal intermodal networks;

[28] http://www.euridice-project.eu/index.php/web/events/60.

- Transport infrastructure providers to support users of the transport network by providing better information about available infrastructure and conditions; and
- Regulators to simplify information gathering for compliance and enforcement purposes.[29]

Work thus far has largely concentrated on the development of a National Single Window (NSW), which is a single gateway or portal at the national level for reporting freight information to government agencies for a specific regulatory purpose. To that end, the project partners have developed a concept for the NSW which involves a common interface for businesses to report all regulatory information in a standard format, regardless of freight mode or nation, as well as an information exchange capability to facilitate the sharing of shipment data between national governments and with EU systems. An initial NSW system has been deployed in Latvia and testing is ongoing.[30]

Data and Communications

- Varies, but systems typically deploy low-cost wireless devices (e.g., RFID tags) to monitor cargo, improve freight information exchange, or integrate with traffic management operations.

Conclusions

The preponderance of the European experience identified in this scan appears to be centered on improving the flow and exchange of information in the supply chain to support efficient freight operations as well as a streamlined regulatory environment. Indeed, each of the projects described here was funded under the European Commission Seventh Framework Programme, which is an EU program aimed towards increasing the global competitiveness of EU countries. Oftentimes the projects are geared towards improving access to technology solutions for small or medium firms that may not have the same level of IT resources as large ones. Collectively, the focus on data interchange, reducing manual processes, and improving shipment visibility make these programs resemble a European version of Electronic Freight Management, though they appear to be larger in scope than anything yet attempted in the U.S.

[29] http://www.efreightproject.eu/default.aspx?articleID=18749&heading=The Project.

[30] European Commission Seventh Framework Programme, *e-Freight Deliverable 3.2: Reference Solutions for Next Generation National Single Windows*, November 20, 2011.

Technology	Description	Strengths	Weaknesses	Implications for FRATIS
SMARTFREIGHT	Better coordination between traffic operations and freight distribution systems to make urban goods movement more efficient, green, and safe	Ability to monitor the volume and duration of stay of trucks within the region, enforcement support Firms benefit from real-time traffic and construction data	There is a lot of "noise" in the available data; systems need to be able to filter this out	The EU has made significant advances in freight information exchange and using mobile technology to improve supply chains, however the scope of this effort seems to be beyond what has been contemplated in the U.S. thus far
EURIDICE	"Intelligent cargo" concept using RFID tags connected to mobile communications and servers to generate real-time cargo updates	Real-time reporting of many parameters, including temperature, position, and ETA	Expensive; unclear whether wide adoption has resulted	
e-Freight	EU framework for efficient exchange of freight data between firms and regulators, and among EU nations	Developed a "single window" for regulatory reporting at the national level	N/A; testing is ongoing	

References

European Commission Seventh Framework Programme, *e-Freight Deliverable 3.2: Reference Solutions for Next Generation National Single Windows*, November 20, 2011.

EURIDICE Consortium, "EURIDICE Fact Sheet," 2007, available at http://www.euridice-project.eu/index.php/web/pubdocs/58.

EURIDICE Consortium, "Intelligent Cargo for Shippers," available at http://www.euridice-project.eu/index.php/web/page/66.

EURIDICE Consortium, "Intelligent Cargo for Logistics Operators," available at http://www.euridice-project.eu/index.php/web/page/66.

European Commission Seventh Framework Programme, *SMARTFREIGHT Final Report*, June 22, 2011, available at http://www.smartfreight.info/outcomes.htm.

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