ITS ePrimer
Module 6: Freight, Intermodal, and CVO

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Learning Objectives

1. Understand the different yet complementary goals of private and public sector applications of ITS freight technologies.
2. Describe private, public, and public/private examples of ITS freight applications.
3. Describe the types of ITS benefits delivered to different freight stakeholders.
4. Show how and why private and public sector ITS applications gravitated to different technologies and communications architectures: applications based on
   - vehicle-centered long range communications vs.
   - infrastructure-oriented vehicle-to-roadside communications.
5. Identify resources that readers can use to increase their understanding of ITS freight applications.
Overview of Freight Functions and Issues

- Freight movement is fundamentally private business
  - Shippers, carriers, and consignees
  - Major focus on efficiency, productivity, customer service
- Federal agencies focus on safety and security
  - USDOT includes FMCSA, FHWA, MarAd, and the Joint Program Office (JPO)
  - DHS includes CBP and TSA

What Private Industry Stakeholders Want from ITS

- Improve planning for physical distribution of goods.
- Support purchase, scheduling, and rescheduling of transportation services.
- Facilitate comprehensive in-transit visibility for carriers and their customers.
- Improve the information flow throughout the supply chain.
- Support supply chain performance evaluation and continuous improvement.
Background of Freight ITS

- Private sector led the way
  - Early adopters of satellite-based location determination among irregular route truckload carriers – early 1990s
  - Dramatic improvements in operating results and service
  - Did not use language of “ITS”

- Public sector use developed more gradually
  - Early Commercial Vehicle Operations (CVO) apps in early 1990s
  - Credentials administration, safety assurance, electronic screening, and toll collection
  - “ITS” language adopted in late 1990s
Communications Architecture

- **Wide area mobile**
  - Vehicle-centric, long range
  - Satellite, cellular, Wi-Fi evolution
  - Usually 2 way data and voice
  - High cost per vehicle
  - Private sector’s focus

- **Short range fixed location**
  - DSRC and infrastructure focus
  - RFID transponders with unique IDs
  - IDs keyed to remote databases
  - Lower cost per vehicle and higher costs on the land-side
  - Public sector’s focus
Core ITS Freight Technologies

- **Asset tracking**
  - “Where is my equipment?”
  - Enables better fleet management and supply chain visibility

- **On-board status monitoring**
  - Vehicle condition sensors
  - Cargo condition sensors
  - Driver behavior sensors

- **Gateway facilitation**
  - Ties in with CVO and CVISN

- **Freight and network status info**
  - Requires major database access and management capabilities
Freight Data Management

Information about what is moving is often as important as the freight itself

- History of freight data quality: it is late, incomplete, and inaccurate
  - Move to “source data automation” triggered by freight transactions
  - Data standardization pays benefits
  - Major strides in Internet era

- Public sector use of freight data
  - Tactical, such as CVO enforcement
  - Strategic, such as data for planning

- Freight data sensitivity
  - Usually proprietary and fiercely protected

- To visit the UPS tracking site, click here
- To visit the FedEx tracking site, click here
Freight Management Functions

Freight management functions relate to

- Information exchange and ITS technologies used by private companies
- Raw materials, components, and finished goods

Freight Management includes four functions

A. Integrated Logistics Management
   - Focuses on all aspects of the supply chain
   - Automation of formerly manual processes and documents
   - Core competencies (in-house) vs. third party logistic (3PL) outsourcing

B. Supply Chain Management
   - Growing global use of Transportation Management Systems
   - Trend toward optimization applications and predictive analytics
Freight Management Functions

C. Carrier and Fleet Management
   ▪ Management of transportation assets
     – Tractors
     – Trailers
     – Containers
     – Chassis

D. Port and Terminal Congestion Management
   ▪ Growth in ocean container traffic increases pressure on U.S. seaports
   ▪ Long queues of idling trucks produce emissions issues
A. Integrated Logistics Management

Scope of Business Logistics Activities

- Sales forecasting and purchasing
- Inbound/outbound/intra-company transport
- Raw material/work in progress inventory control
- Finished goods inventory/warehousing
- Order processing
- Customer service
- Logistics systems administration
- Materials management
- International land domestic shipping
- Computerized distribution applications
B. Supply Chain Management

- Globalization – Imports and Exports
- Enhanced Transportation Management Systems
- Increased rail-truck intermodal
- Increased parcel shipments
- Tracking and tracing of shipments
- Electronic shipping documentation
C. Carrier Fleet Management

- On-board truck management
  - Tractor and trailer RFID tags
  - Transponder location devices
- Driver scheduling and alerts
  - Smartphones and cab communications
  - Hours of service management
- GPS mobile tracking technology
- DOT-sponsored tests of asset tracking
D. Port and Terminal Congestion Management

- Congestion costs the carriers, shippers, and consignees
- Port truck congestion spills over onto the highways and surrounding urban areas
- See FMC Port Congestion Causes Report July 2015
- Port land-side turn time studies to understand the problem
- Yard management systems for greater terminal visibility
- Congestion alerts
- Off-peak hours incentive programs (e.g. PierPass)
Costs of Congestion

- Federal Reserve: - 0.2% GDP because of LA Port congestion in early 2015
- Drewry: $150 million ocean carrier lost from LA vessel turn around delays in late 2014
- Tioga Group: $348 million/year from U.S. drayage delays
  - Time in queues at the gates: $83 million/year
  - Congestion within a container yard: $42 million/year
  - Congestion on highways and streets: $150 million/year
ITS CVO embodies the yin and yang of enforcement and facilitation

Commercial Vehicle Info. Systems and Networks (CVISN) is the central CVO program

- Commercial Vehicle Administration Center
  - Represents multiple public and regional agencies that administer CVO activities
    - Communicate with Field Activities
    - Field Activities communicate with trucks
- Fleet and Freight Management Centers
  - Parts of private firms
- Commercial Vehicle Subsystems
  - On-board equipment to support both CVO and carrier’s business interests
  - Vehicle-roadside CVO links
Core and Expanded CVISN Capabilities

- Core CVISN requires
  - Safety Info. Exchange
  - Credentials Administration
  - Electronic Screening

- Expanded CVISN
  - Open menu
  - Optional extensions

Some Expanded CVISN Projects

1. Virtual Weigh Stations
   Roadside facilities monitored from other locations

2. License Plate Readers
   Image-processing to identify vehicles

3. Oversize/Overweight Permitting
   Correct routing to address mobility, safety, and security concerns

4. Driver Information Sharing
   Focus on high-risk drivers
Deployment Successes

- **PrePass**
  - Largest ITS CVO consortium
  - 301 stations, 31 states
  - Safety, weight, credentials
  - Electronics enable bypass

- **PierPASS**
  - Non-profit, marine terminals
  - Ports of LA and Long Beach CA
  - Congestion, air quality, security
  - Incentives for night operations
Weigh in Motion (WIM)

WIM is the "Holy Grail" of weight limit enforcement

- Enables fully automatic and direct WIM enforcement
- Increases the efficiency and effectiveness of weight limit enforcement
- Virtual weigh station - roadside enforcement facility with remote monitoring (WIM, camera system, and wireless communications)

Several YouTube videos may be interesting:

For an animation illustrating the WIM concept in action, click here.
For a driver’s perspective on and experience of a WIM inspection, click here.
For a law enforcement perspective and WIM technology approaches, click here.
Homeland and Cargo Security

1. Security process and freight data impacts of terrorist attacks

2. Huge bloom of freight-related technology solutions after the terrorist attacks

3. U.S. Government efforts *as a shipper* to better track assets and monitor their status
   - Department of Defense (DOD)
   - Department of Energy (DOE)
Freight Data and Process Impacts of 9/11

Focus on “what is in the box?”
- US CBP institutes “24 Hour Rule” and Container Security Initiative (CSI)
  - eManifest data required 24 hours before loading container on ship
  - Container screening pushed “offshore” to origin ports

Focus on intrusion prevention and detection
- CBP institutes Customs-Trade Partnership Against Terrorism (C-TPAT)
  - “Validated” supply chain security best practices
  - Upgrade cargo seals and sealing practices

“If you want to guarantee supply chain security, then don’t ship anything!”
Bloom of ITS-like Security Technologies

- TSA launches Transportation Worker Identity Card (TWIC)
  - Classic ITS biometric identification card
  - Difficult birth limits enthusiasm among freight sectors
- Publicly and privately funded security initiatives
  - Many start with visibility enhancements that improve supply chain management and security along with it
Bloom of ITS-like Security Technologies

- Trade-lane oriented tests and demonstrations – over 40!
  - Operation Safe Commerce – TSA sponsored
  - "Smart Box" Container Security Devices – CBP sponsored
  - Purely commercial ventures

- No lasting commercial successes
  - Great ideas, but ahead of their time
  - Viable only with government mandates
The Government is a large-scale shipper of freight
- DOD, for the armed forces
- DOE, for nuclear materials

Major interests in safety and security of hazardous shipments
- Arms, ammunition, and explosives
  - Defense Transportation Tracking System (DTTS)
- Fissile materials
  - DOE Transportation Tracking and Communications System (TRANSCOM)

Intelligent Road/Rail Information Server (IRRIS)
- DOD’s ITS-like platform
Freight Facilitation

- Industry and international standards for data exchange
- Data sharing among private sector firms to improve freight efficiency
- Includes Electronic Data Interchange (EDI) and internet-based standards
- USDOT funded projects to enhance facilitation
  - Electronic Freight Management
  - Cross-Town Improvement Project
Electronic Data Interchange

- Process of transferring standard business documents between trading partners
- Backbones of eCommerce is EDI (Electronic Data Interchange), a standard method of exchanging files that was developed in the 1980s
- Bridge between trading partners
  - Value Added Network evolved to File Transfer Protocol via Internet
- Most common electronic transactions
  - Shipment status
  - Invoice
  - Advanced Ship Notice
  - Payment Advice
Electronic Freight Management (EFM)

- DOT-sponsored private sector supply chain demonstration projects
- Internet-based standard freight data exchange among partners
- Import air cargo of apparel demonstrated in Columbus, OH
- Import ocean container by rail demonstrated in Kansas City
- 3PL and drayage trucking demonstrations in Chicago and other cities
- Software bundle available to additional private sector companies
Connections among Corporate Goals, Supply Chain Capabilities and EFM Technologies
Current Freight ITS Research

- Research projects in freight transportation sponsored by Joint ITS Program Office
  - Dynamic Mobility Applications (DMA)
  - Freight Advanced Traveler Information System (FRATIS)
  - Commercial Vehicle Safety Research
Dynamic Mobility Applications (DMA) Bundle

- DMA Freight Problem Statement: Lack of Advanced traveler information has negative effect on
  - Efficient Movement of Freight Transportation
  - Logistics Management Systems
  - Environment of Neighboring Communities
  - Energy Consumption
  - Safety of the Traveling Public

- DMA Proposed Freight Solution: Develop Freight Advanced Traveler Information (FRATIS) applications focusing on
  - Freight Real-time Traveler Information with Freight Specific Dynamic Route Guidance
  - Load/Empty Optimization
FRATIS Applications

- **Freight-Specific Dynamic Travel Planning and Performance**
  - Enhances traveler information systems to address specific freight needs.
  - Integrates data on wait times at intermodal facilities (e.g., ports), incident alerts, road closures, work zones, routing restrictions (hazmat, oversize/overweight).

- **Load/Empty Optimization**
  - Optimize truck/load movements between freight facilities, balancing early and late arrivals.
  - Individual trucks are assigned time windows for pick-up and drop-off.
  - Utilizes travel information and information on port terminal conditions to optimize operations.
FRATIS Demonstration Project

- Three prototype sites:
  - Dallas/Fort Worth
  - Los Angeles
  - South Florida
- Deployment test
- Analysis of daily truck movements for with and without comparison
- Promising technologies if refined and implemented widely.
- Quantitative benefits could not be measured because technologies were not used operationally.
FRATIS Findings and Lessons Learned

• FRATIS had important proofs of concepts
  • automated daily report of expected daily container arrivals
  • Information about availability of containers at a terminal
  • transmission of estimated arrival time of a container
• Advances in trucking company dispatch optimization technology
• Integration of new capabilities into existing systems is essential to a successful test
Commercial Vehicle Safety Research

- Federal Motor Carrier Safety Administration (FMCSA) research into smart technologies for truck safety
  - Research Division mission: reduce the number and severity of commercial motor vehicle (CMV)-involved crashes through:
    - Systematic studies, best practices and technologies for driver, vehicle, roadside
Commercial Vehicle Safety Research

- **FMCSA Research Division Programs**
  - **Integrated Vehicle-based Safety Systems (IVBSS) initiative to accelerate the introduction of integrated vehicle-based safety systems**
  - **Onboard Monitoring to Improve Commercial Motor Vehicle Safety effort**
    - Technology suite will provide driver performance feedback on a number of critical safety factors
  - **Safety and Security Technology Deployment**
    - Tests and encourages deployment of collision warning systems with adaptive cruise control, stability control systems, lane departure warning systems, and vehicle tracking systems
Benefits of ITS Freight Applications

- Measured or Predicted Benefits
  - Decreased empty miles
  - Fuel savings
  - Process improvements
  - Reduced terminal queue time
  - Enhanced vehicle safety
  - Reduced emissions
- DOT-sponsored benefits analyses
- Private Sector and Public Sector benefits
- Industry-Government partnerships
## CEFM’s Benefits

<table>
<thead>
<tr>
<th>Supply Chain Function</th>
<th>CEFM Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Productivity:</strong></td>
<td></td>
</tr>
<tr>
<td>Shipping Documentation</td>
<td>♦ Reduced stakeholder data entry by 50-75%</td>
</tr>
<tr>
<td>Automated visibility data</td>
<td>♦ Improved data accuracy at freight station by 25%</td>
</tr>
<tr>
<td>Automated messaging</td>
<td>♦ Improved warehouse data availability by 10%</td>
</tr>
<tr>
<td></td>
<td>♦ Better staff planning and forecasting of workload</td>
</tr>
<tr>
<td><strong>Service Quality</strong></td>
<td></td>
</tr>
<tr>
<td>Automated status data</td>
<td>♦ Improved # shipments/week processed by Customs broker by 18%</td>
</tr>
<tr>
<td></td>
<td>♦ Reduced time to research priority shipments by 27 minute/day</td>
</tr>
<tr>
<td><strong>Data quality and availability:</strong></td>
<td></td>
</tr>
<tr>
<td>Frequency of data updates</td>
<td>♦ Eliminated most re-keying through near real-time data</td>
</tr>
<tr>
<td>Data accuracy</td>
<td>♦ Improved data accuracy by 25%</td>
</tr>
<tr>
<td>Data timeliness</td>
<td>♦ Improvement in data receipt by 6-72 hours</td>
</tr>
</tbody>
</table>
## EFM Case Study Benefit/Cost Ratios

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Benefit/Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kansas City SmartPort - DEMDACO</td>
<td>2.49</td>
</tr>
<tr>
<td>WorldWide Integrated Supply Chain Solutions</td>
<td>7.33</td>
</tr>
<tr>
<td>Interdom Partners-Agmark</td>
<td>0.94</td>
</tr>
<tr>
<td>Interdom Partners-Pride</td>
<td>6.62</td>
</tr>
<tr>
<td>Express Systems Intermodal</td>
<td>0.96</td>
</tr>
<tr>
<td>Fellowes (Simulation)</td>
<td>18.39</td>
</tr>
<tr>
<td>Carter Transportation</td>
<td>1.36</td>
</tr>
<tr>
<td>ACME (Simulation)</td>
<td>127.15</td>
</tr>
</tbody>
</table>
## FRATIS

### Performance Measures & Transformative Targets

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Reduction Targets (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Near</td>
</tr>
<tr>
<td>Number of bobtail trips</td>
<td>10</td>
</tr>
<tr>
<td>Terminal queue time</td>
<td>20</td>
</tr>
<tr>
<td>Travel time</td>
<td>15</td>
</tr>
<tr>
<td>Number of freight-involved incidents</td>
<td>30</td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>5</td>
</tr>
<tr>
<td>Level of criteria pollutants</td>
<td>5</td>
</tr>
<tr>
<td>Level of greenhouse gas equivalents</td>
<td>5</td>
</tr>
</tbody>
</table>

**Key:** Near-term: next 5 years, Mid-term: 5-10 years out, Long-term: > 10 years
## CVISN Benefits

### Cumulative Benefits from PrePass Inspection Bypasses 1997–2012

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Bypasses</td>
<td>522,471,210</td>
</tr>
<tr>
<td>Driving Hours Saved</td>
<td>43,882,008</td>
</tr>
<tr>
<td>Dollars Saved</td>
<td>$2,626,328,465</td>
</tr>
<tr>
<td>Gallons of Fuel Saved</td>
<td>210,633,637</td>
</tr>
<tr>
<td>Reduced Emissions*</td>
<td>121,877,158</td>
</tr>
</tbody>
</table>

* Carbon monoxide emission reductions are calculated in metric tons
Industry Benefit Observations

- Web-based solutions are more accessible to small and medium-sized companies
- Most EFM benefits to date accrued to large companies
- Benefits grow with familiarity and experience
  - The longer visibility technologies were in place, the greater the realized benefits
- Major users of ITS technologies report better partner integration and greater supply chain visibility. For example:
  - reduction in transportation costs
  - reduction in safety stocks
  - reduction in processing effort
Cautionary Words about Benefits

Great technology does not guarantee great benefits

- Management vision, skill, and engagement is necessary
  - Vision, to see possibilities…
  - To mobilize the organization
  - And skill in depth to deploy and implement successfully

- Effective implementation is necessary, not sufficient
  - Sustained benefits require effective maintenance
  - New technologies often require new methods and culture

For successful ITS freight innovations, pay attention to institutional and deployment issues.
Future Directions of ITS Freight Research

- Vehicle-to-vehicle truck research
- Cloud-based system management
- Predictive analytics
- Natural gas engines and infrastructure
- Onboard technologies
- Advanced technology concepts

Check out these advanced technology innovators

- Freight Shuttle
- SeaTruck
Summary

1. The module has provided background on and descriptions of private sector and public efforts in freight ITS.
2. Both private and public sectors use ITS freight technologies to improve safe and efficient freight movement.
3. EFM and FRATIS are examples of public/private ITS apps.
4. The public/private apps benefit from technology advances and yield:
   - private sector dollar benefits
   - better policy decisions by public sector
References

- The Johns Hopkins University Applied Physics Laboratory (JHUAPL), "Commercial Vehicle Information Systems and Networks (CVISN) System Design Description,” NSTD-09-0238 v. 4.0, June 2009.
- Connected Vehicle Pilot Deployment Program Phase 1, Concept of Operations (ConOps), ICF/Wyoming Draft Report FHWA-JPO-16-287 December 15, 2015
Questions

1. What have been major contributions of DOT-sponsored research in freight ITS?
2. Do you see symmetries between freight and personal vehicle ITS research? Provide examples to support your answer.

Also, see the suggested discussion questions on slides:
- 6: Long- vs. short-range fleet communications
- 16: Onboard technologies
- 21: Customs and Border Protection’s 24-hour rule
- 38: Institutional barriers to freight ITS adoption
- 41: Harvesting Web benefits and company size