

III. INTELLIGENT FREIGHT TECHNOLOGY BENEFITS

Successful deployments of intelligent freight technologies can yield direct benefits to private firms and the public sector, and indirect benefits to the freight network. This chapter describes each and weaves in what has been learned about them from the FOTs and other sources.

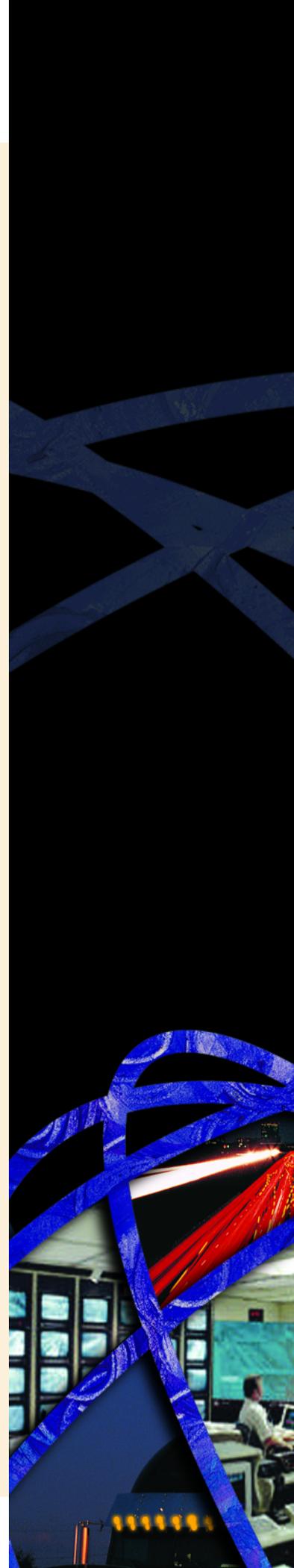
PRIVATE SECTOR BENEFITS

The ability to capture the quantitative and qualitative benefits available to businesses is the broadest overall trigger for private decisionmakers to deploy intelligent freight technologies. Some of those benefits are already well-proven, some are not, but all can be tied to three freight operations strategies: increasing efficiency, improving reliability and service, and enhancing shipment integrity.

Increased Efficiency and Productivity

Efficiency and productivity benefits reduce the cost of doing business. They tend to be quantitative, easier to measure than other benefits, and easiest—*although not necessarily easy*—to justify to skeptical corporate comptrollers.

The core rationale is using more accurate, timely, and detailed data about a host of operating factors, processed with algorithms or models, to **better utilize people and equipment**. Truckload carriers, for example, proved to themselves in the early 1990s that near real-time satellite truck location data and two-way digital communications could be a huge money-maker. Productivity benefits cross functional lines, affecting empty-miles, maintenance, and indirectly even driver turnover. In the Hazmat FOT, the productivity benefits of asset tracking were estimated to be between \$7,866 and \$15,222 annual savings per tractor, the largest benefit being a higher percentage of revenue miles (Reference 6.B). In one of the chassis tracking FOTs, the estimated annual savings per chassis was \$210.35, mostly from increased utilization (Reference 5). The BEST and SST projects reported about \$400 per container in benefits to shippers, mostly in inventory benefits from better asset tracking (References 7.A and 7.B).



Good automated tools that exploit intelligent freight data enable operators to reduce administrative burdens, **shorten processing times**, and therefore reduce cycle times as well. The ESCM, Pacific Northwest, and HazMat FOTs all illustrated such benefits. The independent evaluation of the ESCM FOT, for example, reported benefits of up to \$16.20 per air-freight shipment from faster document preparation and security processing (Reference 1).

Automated interfaces with regulatory agencies **eliminate most stops at weigh stations** and can reduce border-crossing delays. Regional intelligent freight data networks and terminal gate scheduling systems **reduce non-productive waiting time**, emissions, and wasted fuel during idling. The independent evaluator on the FIRST project estimated that savings per drayage trip to an ocean terminal would range from \$21.36 to \$247.57 (Reference 3).

Better visibility coupled with better control systems enables operators to **minimize errors** and, when they occur, find and fix them more quickly and easily. Labor previously spent on “expediting” problems is put to better use, and fewer loaded miles are wasted on duplicative movements. In Norfolk, a yard management system was coupled with a control tower to facilitate oversight of container movements throughout the terminal. Tied to the truck entry gate, the system tells a driver where to pick up or drop off a container. The results, although not quantified, were tangible (Reference 23).

Net, this class of benefits means that operators can deliver a given level of service with fewer resources, enabling them to reduce slack capacity or provide higher levels of service without adding capacity. Beneficiaries may be carriers, terminal operators, third parties, and shippers.

Triggers and barriers. The credibility of savings estimates is very important to firms at the cusp of a new deployment decision. Industry members of an ROI panel at a fleet management technologies conference generally agreed that they needed firm estimates of project payback within 12-18 months in order to proceed.³ The representative of a major package express firm, however, said his firm was convinced by their positive experience with asset tracking technologies and had not done a formal ROI analysis in six years. From another perspective, success with mobile tracking technologies transformed the potential barrier of driver skepticism into a positive as many drivers' take-home pay increased with the proportion of revenue-miles driven.

Improved Reliability and Service

Improving reliability and service provides both quantitative and qualitative benefits. However, because even the quantitative metrics are difficult to convert to revenue improvements or cost reductions, this class of benefits is more likely to be treated as qualitative and regarded with skepticism.

Improved reliability—**better schedule adherence**—is at the core of this benefit for freight transportation industries, and the reason lies in inventory theory. The same logic applies whether one's inventory is transport equipment or the goods being moved: variability in process time has an exponential effect on safety stock levels, while average process time has a linear effect. Simply put, small improvements in reliability deliver greater potential gains than small improvements in average speed. A reliability improvement strategy supports goals of increasing customer loyalty, winning more profitable customers, and growing market share. Management teams that are committed to a quality improvement philosophy, however, recognize that better quality can also lower costs, and that efficiency and improved reliability strategies may

³ Eyefortransport, "Wireless and Mobile Technology for Trucking and Delivery Fleets," Miami, FL, January 17-18, 2005.



reinforce each other. Intelligent freight visibility and control technologies can improve both reliability and speed.

Better visibility and control via intelligent freight technology also increases **operational flexibility**. Disruptions and delays, realized soon enough, permit corrective action by the carrier and the carrier's customer, conceivably avoiding shutdown of a just-in-time production line. Another benefit is the opportunity to respond more rapidly to priority changes, as with diversion of en route shipments.

The most qualitative benefit is **shipper confidence**, especially the confidence that a freight transporter will deliver as promised or provide advance notice of problems and even alternative solutions. Qualitative or not, customer confidence is a catalyst that generates business loyalty and encourages more aggressive efficiency measures throughout a supply chain.

Intelligent freight tools can also generate confidence related to regulations, assuring regulators and customers that a firm complies fully with safety or security mandates. Higher confidence may translate to less special (added) surveillance and monitoring.

Triggers and barriers. Industry stakeholders take very different views of service improvement and qualitative benefits. The Chief Financial Officer of a major dray firm, speaking on the ROI panel mentioned earlier, said he totally discounts soft benefits: a project wins or loses funds based on hard numbers, and any soft benefits (qualitative) from successful projects are pure gravy. Representatives of truckload carriers, however, citing their solid experience with fleet tracking systems, said they consider the spin-off effects to be potent and important.

Enhanced Shipment and Service Integrity

Improving shipment integrity also provides quantitative and qualitative benefits. Shipment and service integrity includes both the “pre-9/11” (protection against theft and traditional contraband, such as narcotics) and “post-9/11” (protection against terrorism) forms of security. Two sets of technology applications are especially relevant to improving shipment and service integrity. The first are identification and validation tools, such as biometrics and smartcards, that reduce the risk of unauthorized pickups and deliveries. The second, and the more flexible in terms of benefits, are the combination of asset tracking and on-board sensors.

PRE-9/11 ISSUES. Electronic intrusion detection and asset tracking technologies should help reduce theft. Although there are no verifiable figures available, cargo theft in the United States is anecdotally reported to be anywhere from \$2 billion to \$18 billion a year. Paradoxically, the large losses imply some good news: they create the potential for significant dollar benefits from effective use of theft-reducing intelligent freight technologies. However, a Stanford University study that estimated theft-reduction benefits related to intelligent freight technologies was conservative in its base numbers and forecast savings of 4 percent to 5 percent of the value of cargoes (Reference 7.B).

Long-distance mobile asset tracking may make it possible to interrupt some crimes in progress. For example, if a trailer door is opened outside an approved geofence, an automated message to the dispatcher could generate a request for police to go to the scene. This could also be a post-9/11 benefit. A thief was actually caught in the act thanks to the mobile chassis tracking in the Cargo*Mate FOT (Reference 4, p. 56).

Transportation services are stolen or “misappropriated” as well as cargo, and intelligent freight technologies can help carriers reduce these problems. For example, some customers misuse trailers, chassis, and containers during free time and some terminal operators and interlining carriers may be careless in using equipment belonging to

other companies. Long-distance mobile asset tracking of untethered assets offers fleet operators a tool to identify and curb abuse. A dray fleet reduced its missing chassis from 4 percent of the fleet to zero during the Cargo*Mate FOT (Reference 4, pp. 43-44).

POST-9/11 ISSUES. Intelligent freight technology benefits can address two of the three requirements for a secure supply chain. They can help reduce the risk of undetected tampering with shipments in progress, and they can help provide accurate and timely information related to the shipment. They offer little contribution towards the third requirement, assuring the integrity of the trailer or container loading process.

Post-9/11 terror threats uncovered a new deployment trigger. Several major firms are thinking about the shipment integrity issue quite differently, as a means to protect their brand equity from damage related to terror threats. As one major retailer put it, protecting brand equity means keeping your corporate logo out of network news stories about terrorist penetration. In more formal terms, these firms are experimenting with intelligent freight technologies in order to both reduce the risk of shipments being compromised and to provide evidence to regulators and customers of their efforts. When corporate marketing managers become attuned to the brand equity issue, they also become effective internal allies for supply chain managers pursuing resources for security innovations.

Biometric smart cards, like these, contain information on the driver, including a photocopy of a commercial driver license and a thumbprint of the driver. This information is used to gain access to ports and intermodal transfer facilities. Source: American Transportation Research Institute



Triggers and barriers. One potential trigger in this area is underappreciated: the total (direct and indirect) cost to firms of cargo theft. If firms had better data on the indirect costs, then security officers might find comptrollers more willing to fund their projects. On the positive side of the ledger, the ESCM and Hazmat FOTs indicated that one potential barrier to intelligent freight security technologies is likely to be less of a problem: truck drivers reacted positively to the biometrics and smart cards as a replacement for manual credentials that highlight personal information.

PUBLIC SECTOR BENEFITS

Intelligent freight technologies produce benefits for public agencies and for the public at large. Some benefits mirror those of the private sector and others clearly move into different territory.

Public agencies derive direct **efficiency and productivity** benefits, as when state highway enforcement agencies use compliance facilitation applications to increase significantly the number of trucks that an inspector can process in an hour. Another example is the ability of U.S. Customs officials to screen more inbound containers and cross-border trailers with non-intrusive inspection technologies than they could manually.

Intelligent freight technologies also permit those same agencies to improve the **quality of the service** they deliver, akin to the way the technologies enable freight transportation firms to deliver more reliable and flexible service. Compliance facilitation systems, such as the CVISN network, enable carriers—and their customers—to save money by reducing time lost at inspection stations. Shipper and carrier members of the Customs-Trade Partnership Against Terrorism (C-TPAT) are to enjoy a higher tier of benefits and “almost” no entry inspections if they use approved “smart box” tech-



nologies.⁴ The concept behind both the CVISN and CBP smart box programs is to use intelligent freight technologies as catalysts that enable agencies to reward high quality, high compliance shippers and carriers.

The public sector equivalent of shipment integrity benefits includes broader benefits for the public and the nation at large. To the degree intelligent freight technologies enhance security against terrorism, they contribute to **national security**. One could argue that those benefits—reducing the risk of freight-related terror events—are far greater for society as a whole than they are for individual firms, even those attuned to protecting their brand equity.

Successful intelligent freight technology deployments can yield significant **safety benefits**. On-board vehicle sensors may reduce the number of crashes by calling driver attention to under-inflated tires before they fail. Driver performance monitoring, by enabling firms to educate and improve driver behavior about high speeds and hard braking, can reduce fleet-wide incidents. Weigh-in-motion sensors can increase enforcement effectiveness and reduce the number of incidents related to the overweight conditions of vehicles. More generally, just as intelligent freight technologies can enable agencies to reward quality shippers and carriers, the technologies permit agencies to focus their enforcement attention on poor performers, yielding proportionally greater benefits.

Better **emergency response** is closely related to safety, and intelligent freight technologies can contribute direct improvements. In the Hazmat FOT, evaluators found that rapid notification of incidents helped improve the effectiveness of incident response and reduce the consequences. The benefits were difficult to quantify but included lower environmental mitigation costs and less potential public exposure to hazmat releases (Reference 6.B).

⁴ Bill Mongelluzzo, “Customs to require ‘smart boxes’ for C-TPAT,” *Journal of Commerce Online*, Feb. 2, 2005.

To the degree that intelligent freight technologies succeed in smoothing flows around major hubs like ports, border crossings, and intermodal terminals, tangible **environmental and quality-of-life** benefits will result. Reduced congestion means fewer trucks and other vehicles stuck in traffic, burning fuel and affecting air quality. It also means less stress on affected neighborhoods and less time wasted sitting in traffic.

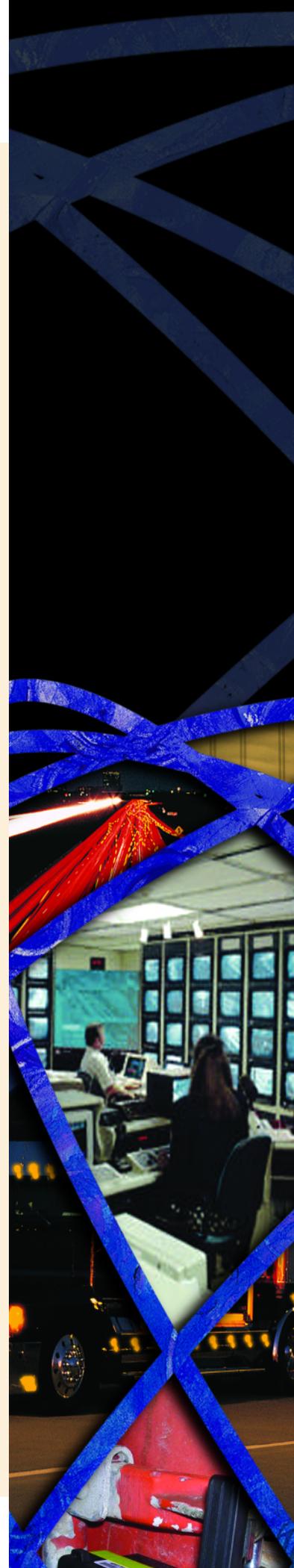
Perhaps the major public rationale for and the most important long-term benefit of investing in intelligent transportation systems is to reduce congestion, enhance mobility, and **increase the effective capacity** of transportation infrastructure. The Freight Analysis Framework estimates that U.S. freight volumes will increase by approximately 70 percent between 1998 and 2020. Given the growing role of international trade in the U.S. economy, container volumes through major ports could triple.⁵ Better asset tracking, enhanced gateway facilitation, and more effective freight-network status information are tools that may enable better management that growth.

Triggers and barriers are, of course, different for public-sector benefits. Safety, long-term congestion mitigation, and national security are major policy priorities that trigger government action and support for programs like the FOTs. Funding constraints, competing demands for public funds, and concerns about proper government roles tend to be the barriers.

FREIGHT NETWORK BENEFITS

Network benefits are qualitatively different than the business benefits discussed earlier. The focus shifts from results achieved by individual firms to system effects, culminating in macroeconomic changes in productivity and prosperity. There are two levels of network benefits. Although the first is significant, the second can be profound.

⁵ U.S. Department of Transportation, Federal Highway Administration, *Freight Analysis Framework*, 2002.





First-order network benefits have to do with the costs and benefits of expanding network implementation. Adding to an existing network, especially a telecommunications and computing network, usually lowers marginal and average costs. Think of an RFID-based truck or container-tracking network: the initial deployment has high fixed cost because the entire infrastructure is new. Adding new trade lanes, however, should lower the marginal and average infrastructure cost. Once terminal X is instrumented to serve trade lane A, there will be no further costs for X to serve trade lane B when it is added to the network. Similarly, in a long-distance mobile communications network, the marginal cost of building the network management center will be higher for the first deployment than it should be for scaling up to add capacity (Reference 7.A).

Shrinking deployment costs create positive dynamics. As the project economics become attractive to more users, deployment accelerates and more supply chains begin to capture the business benefits of the intelligent freight innovations. The total benefit pie can grow exponentially.

Second-order network benefits are the effects on other industries and the economy as a whole brought about by higher quality, lower cost transportation services. Typically for network industries such as freight, the sum of individual projects underestimates the value of the network as a whole. Scale is important particularly when investments help link industries and regions together. Four major examples in U.S. history are the opening of the Ohio and Mississippi Rivers to trade in the early 19th century, the transcontinental railroad in the last half of the 19th century, the Interstate Highway System after World War II, and, more recently, the Internet and wireless communication networks (Reference 13.B).

An improved freight network generates a productivity effect. It allows industries that depend on freight transportation to produce the same amount of goods and services

for less. An improved system also triggers what economists would call a factor demand effect. Given better transportation, firms and industries can change how much they use of other economic inputs, such as labor, intermediate goods, and private capital. These changes may result in greater efficiencies through investment in different economic inputs. The cost reductions caused by productivity and factor demand effects will, in turn, stimulate increased overall demand.

In response to network improvements, industry changes how much it costs to produce goods, then changes how it produces goods, and finally changes how much it produces. Better freight networks stimulate shifts in the demand and supply curves for goods and services—an improved freight network generates economic growth and greater prosperity (Reference 13.A).

Recent history offers a powerful illustration of the potential value of such shifts. In 1980, 16 percent of the U.S. Gross Domestic Product (GDP) went to logistics costs—essentially transportation plus inventory costs. By 2003, the logistics share of GDP had dropped to about 9 percent, costing about \$650 billion less in 2003 than it would have at the 1980 level.⁶ Four factors contributed to that drop, two of which had little to do with transportation—shifts from manufacturing to service industries and generally lower interest rates, which cut the cost of holding inventory. The other factors, however, were transportation deregulation and the revolution in information technologies. Deregulation allowed greater efficiencies and the information and communications revolution helped significantly to capture them.

⁶ Council of Logistics Management, *Globalization: 15th Annual State of Logistics Report, 2004*; and Cass Logistics, *12th Annual State of Logistics Report, 2001*.

Triggers and barriers are very different in the case of second-order network benefits. While all of the private and most public benefits grow out of particular project decisions, all second order network benefits flow from the accumulation of successful implementations—the whole being greater than the sum of the parts. There is no singular barrier to network benefits, just the accumulation of barriers to successful project adoptions. Similarly, there are no direct triggers for the network benefits, just the sets of triggers that may break loose promising intelligent freight technology projects. In essence, transportation network improvements themselves are triggers that stimulate economic growth. The way to accelerate realization of network productivity improvements is to accelerate progress toward effective intelligent freight technology deployments.