U.S. Department of Transportation
Federal Highway Administration

Intelligent Transportation Systems (ITS)

Intermodal Freight Symposium

Workbook

Introduction

Introduction

On September 30, 1996, the Federal Highway Administration's ITS Joint Program Office and the National Highway Institute hosted an ***Intermodal Freight Symposium.*** The symposium brought together public and private sector experts in fright movement and intelligent transportation systems to exchange information and explore emerging trends. The symposium covered a broad range of topics, including intermodal freight logistics, ITS freight applications, the federal role and key partnerships.

Information presented at the Intermodal Freight Symposium has been collected in this Workbook. The Workbook is divided into three parts:

- ***Part 1:Intermodal Freight Movement-fhe Big Picture.*** This material was presented by John Vickerman of Vickerman.Zachary.Miller (VZM)/TranSystems, and was originally developed for an NHI Training Course entitled "Landside Access for Intermodal Facilities."
- ***Part 2: ITS Applications for lntermodal Freight.*** This material was also developed and presented by John Vickerman of VZM/TranSystems.
- ***Part 3: Intelligent Transportation Systems and Intermodal Freight Transportation.*** This is a reprint of a report prepared by the Volpe National Transportation Systems Center in December, 1996. It covers information presented by Michael Onder and Harry Caldwell on the role of the public sector and the need for effective public/private partnerships.

For further information regarding this Workbook, please contact Michael Onder at the ITS Joint Program Office (202-366-2639) or John Vickerman at VZM/TranSystems (703-758-8800).

PART 1: Intermodal Freight Movement

Part 1: Intermodal Freight Movement-The Big Picture

Part 1:

Intermodal Freight Movement – The Big Picture

Objective: This session introduces the major concepts of intermodal freight transportation logistics, intermodal facility operations (seaports and waterways, air cargo, freight rail and trucking), historic practices and future trends affecting the planning and design of intermodal facility access. Participants will develop an understanding of the physical and economic factors shaping the future of intermodal freight transportation.

Transportation Logistics and U.S. Ports

Possibly the most significant trend in freight transportation is the continuing growth of containerization. To many transportation professionals, intermodalism is synonymous with the movement of intermodal freight containers by ship, truck and rail.

In the first half of this century, general cargo movement was accomplished using a "break-bulk" operation, a time-consuming and labor-intensive process in which cargo ships were loaded and unloaded with crates in all sizes and shapes or on pallets, typically using shipboard cranes and requiring three to five days to turn a ship around. Import cargo would then be moved off the ship to the pier or adjacent warehouses, where it would be sorted for delivery to trucking companies or rail carriers.

Although there were experiments with containerization in the early 1900s its birth is generally dated to 1956, when a Pan Atlantic (later Sea-Land) ship was loaded with 58 specially designed truck-trailer vans without their chassis (Transportation Research Board Special Report #236). The basic principle is that a pre-loaded container arrives on a ship, is unloaded using a landside crane, is moved to a storage area within the terminal equipment and is eventually transferred to truck or rail for ultimate delivery; the reverse applies to exports.

The main advantages of containerization are: 1) loading and transportation equipment can be standardized, supporting capital investment in specialized facilities and reducing the time and labor necessary to transfer between modes and 2) cargo does not need to be unpacked, sorted and re-packed at transfer points, also reducing the time and labor associated with mode transfers.

Logistics – The Key to Global Transportation Competitiveness

"The key to maintaining competitive advantage in the future will be the ability to integrate and leverage global resources in a way that further streamlines the logistics process and improves the company's response to customer's needs."

Clifford M. Sayre
Vice President
E.I. du Pont de Nemours and Co.

Source: Hearings on Review of the Shipping Act of 1984, Sept. 1991

Real Time Integrated Logistics (IL) is based on the Supply Chain Management Process (SCMP)

"The management of the flow of materials and related information in an integrated manner throughout the supply chain – from the initial identification of customer needs through fulfillment of those needs... to achieve competitiveness advantage.. . "

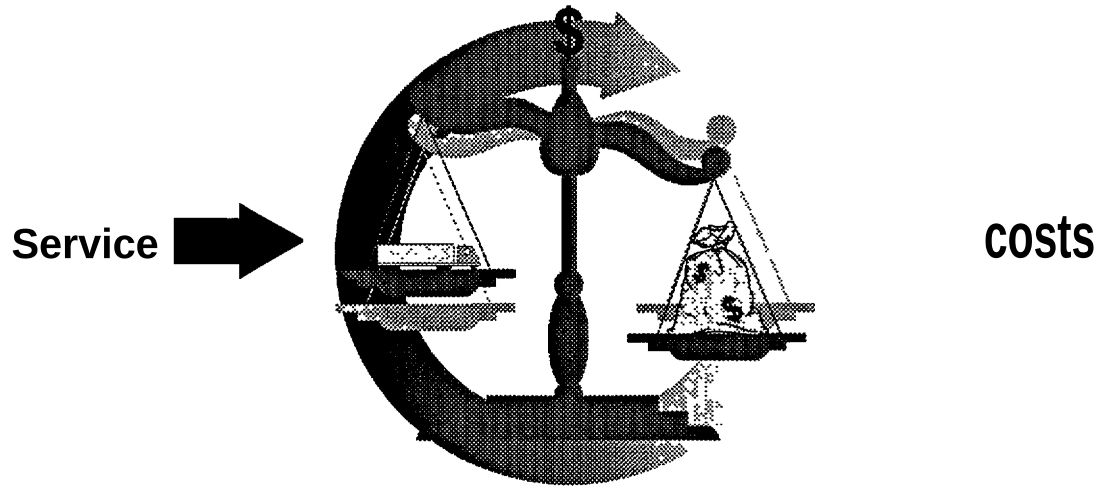
Clifford M. Sayre
Vice President
E.I. du Pont de Nemours and Co.

Source: Hearings on Review of the Shipping Act of 1984, Sept. 1991

"We are committed to doing everything we can to ensure that intermodal freight movement is efficient and seamless. We know that no matter how efficient the individual components of the transportation system may be, the key to timely movement of international freight is the intermodal connection."

Frederico Pena
Secretary of Transportation
April 12, 1993

Todav's Intermodal Logistical Goal

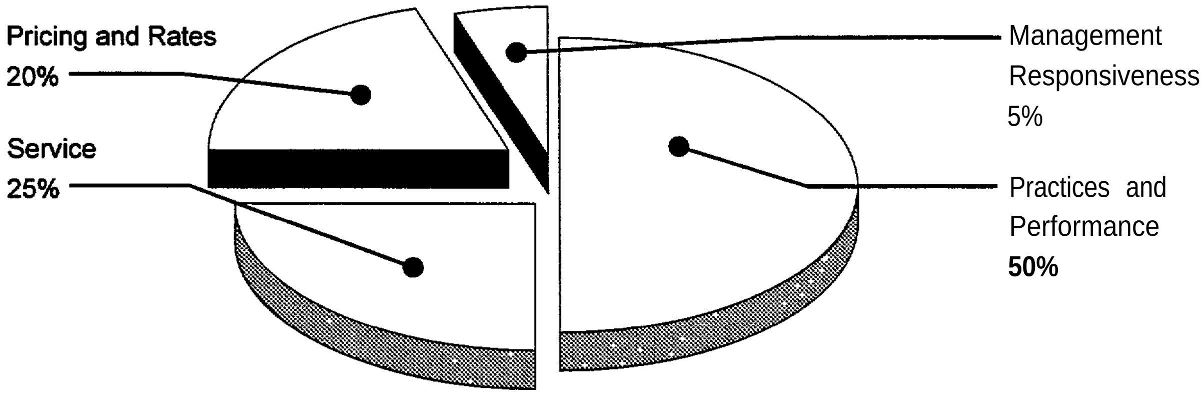


- Minimize total system costs: through logistical tradeoffs and multiple client service "fits" (logistical simulation).
- Meet and exceed customer service requirements.

Source: Vickerman . Zachary . Miller

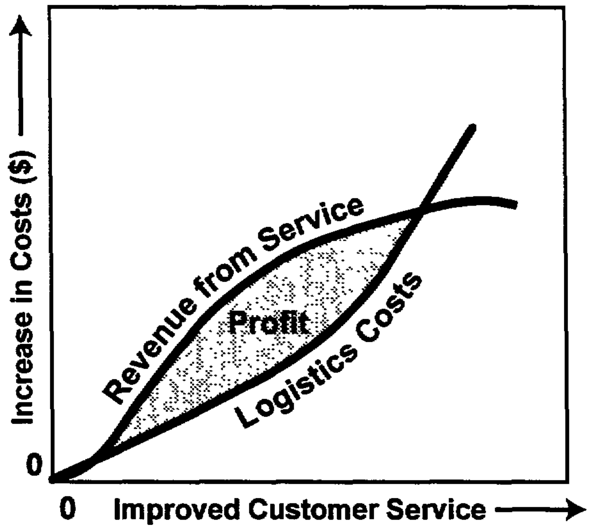
"75% of the Private Sector Freight Decisions are Based on Service and Performance"

Carrier-Selection Criteria



Source: Union Carbide international Transportation Services

A Generalized Logistics Trade-Off at Varying Levels of Customer Service



Source: Vickerman · Zachary · Miller

The Automotive Industry's Next Step in J.I.T. Volvo Transport Corporation's Logistic Strategy

- *Volvo is geographically disadvantaged in Europe by 700 to 1,000 kilometers compared to high end market competitors (Mercedes, Audi, etc.).*
- *One-half of Volvo's product value is transportation distance. Up to 97% of Volvos are sold outside Sweden. 70% of Volvo parts are imported.*
- *Containerize autos (2 over 2) using J.B. Hunt's Autorack System.*
- *Reduce in-transit and stock point inventory by*
    - *Customer personal specification.*
    - *Delivery by high speed vessels.*
    - *Minimal dwell terminals using high speed air-cushion vessel unloading.*

Source: American Shipper, February 1995

World Container Port Ranking 1993
(lop 20 Ports) (Twenty-Foot Equivalent Units – TEUs)

1	Hong Kong	9,620,000	11	NewYork	2,054,333
2	Singapore	9,000,000	12	Keelung	1,969,500
3	Kaohsiung	4,249,520	13	Antwerp	1,865,000
4	Rotterdam	4,200,000	14	Dubai	1,679,000
5	Busan	2,929,815	15	Felixstowe	1,638,644
6	Kobe	2,692,000	16	San Juan	1,617,000
7	Hamburg	2,500,000	17	Tokyo	1,450,000
8	Los Angeles	2,400,000	18	Bangkok	1,435,525
9	Yokohama	2,157.000	19	Bremen	1,363,475
10	Long Beach	2,079,491	20	Oakland	1,237,287

Source: Port Development International – 1994

Major U.S. Container Ports in Comparison to the World Port System

- *In 1993 the Ports of Singapore and Hong Kong each handled over 9 million TEUs.*
- *By the year 2011 Hong Kong will handle 32million TEUs.*
- *The 1993 throughput for America's two largest* **port** *areas (New York/New Jersey and Los Angeles/Long Beach) was just over 6.5 million TEIJs.*
- *America's top ten container ports had a 1993 throughput of 12 million TEUs.*

Source: The Economist, April, 1994; Containerisation International; VZM

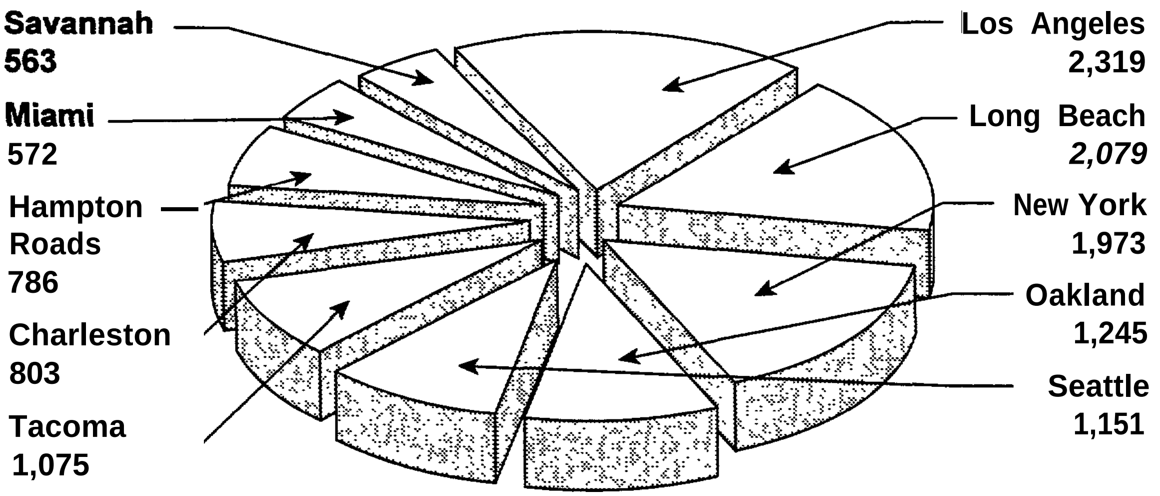
The most productive U.S. intermodal port terminals are not as productive as the best international terminals by a factor of more than

2 to1

The Port industry Today

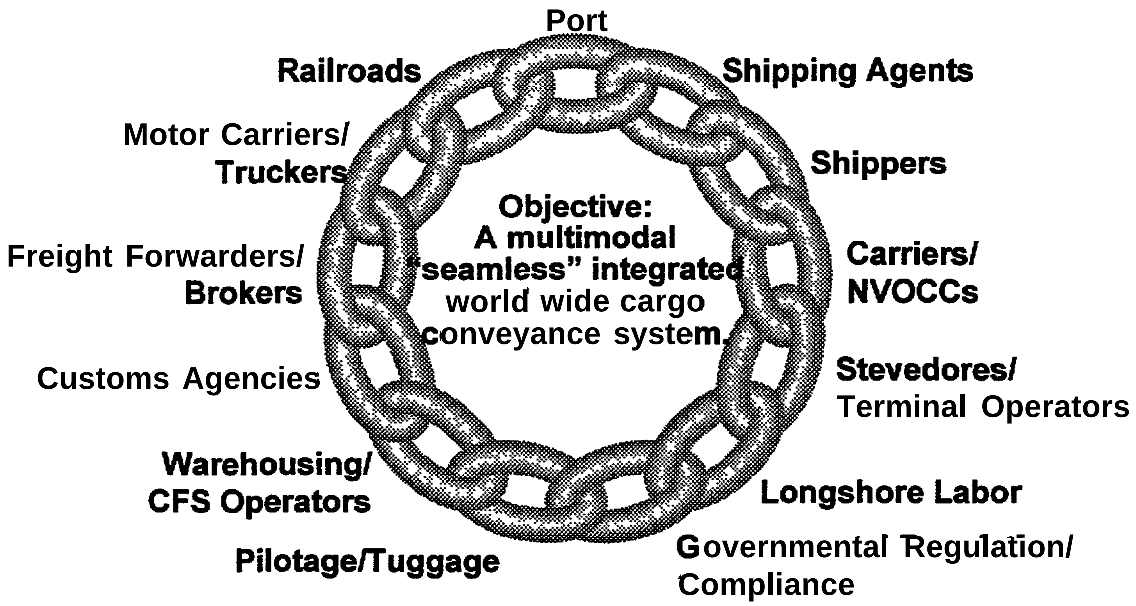
- *967.5 Million Short Tons of Cargo Worth $467.3 Billion*
- *185 Commercial Deep Draft Ports*
- *3,214 Ship Berths*
- *1,914 Terminals*
- *Serving 249,000,000 Americans*
- *Served by 28 Terminal and Beltiine Railroads*

Top 10 U.S. Containerports in 1993 *(in thousands of TEUs of international cargo)*



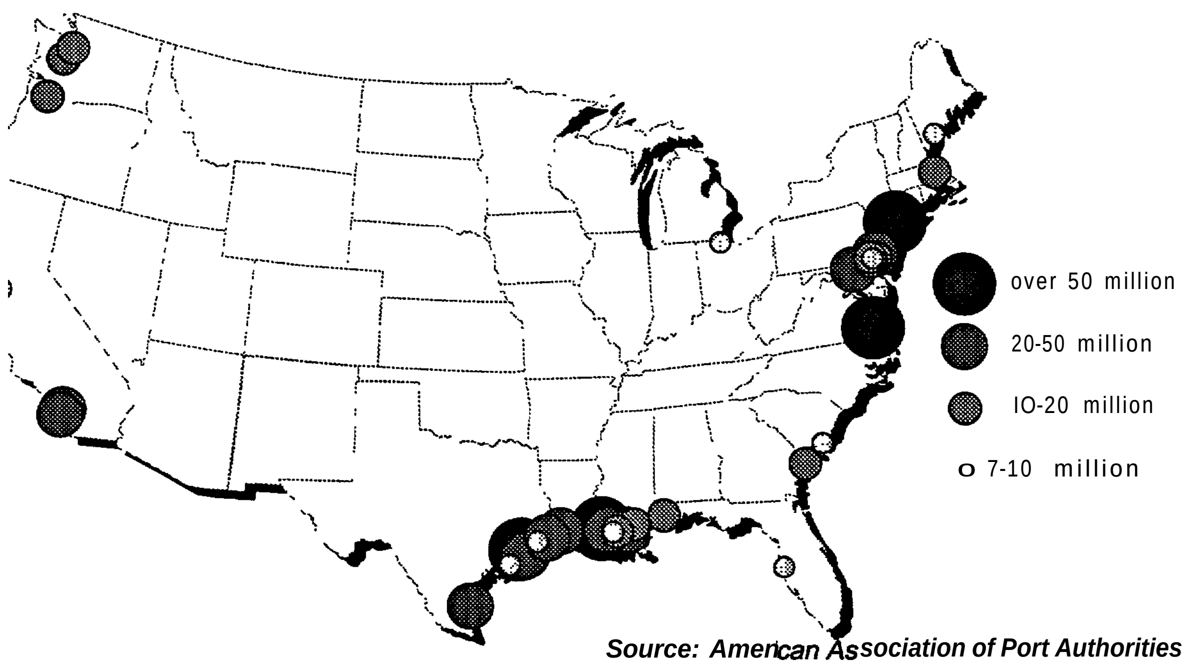
Source: AAPA

The "Port": One of the Many Diverse Constituencies in the Cargo Transportation Logistics Chain



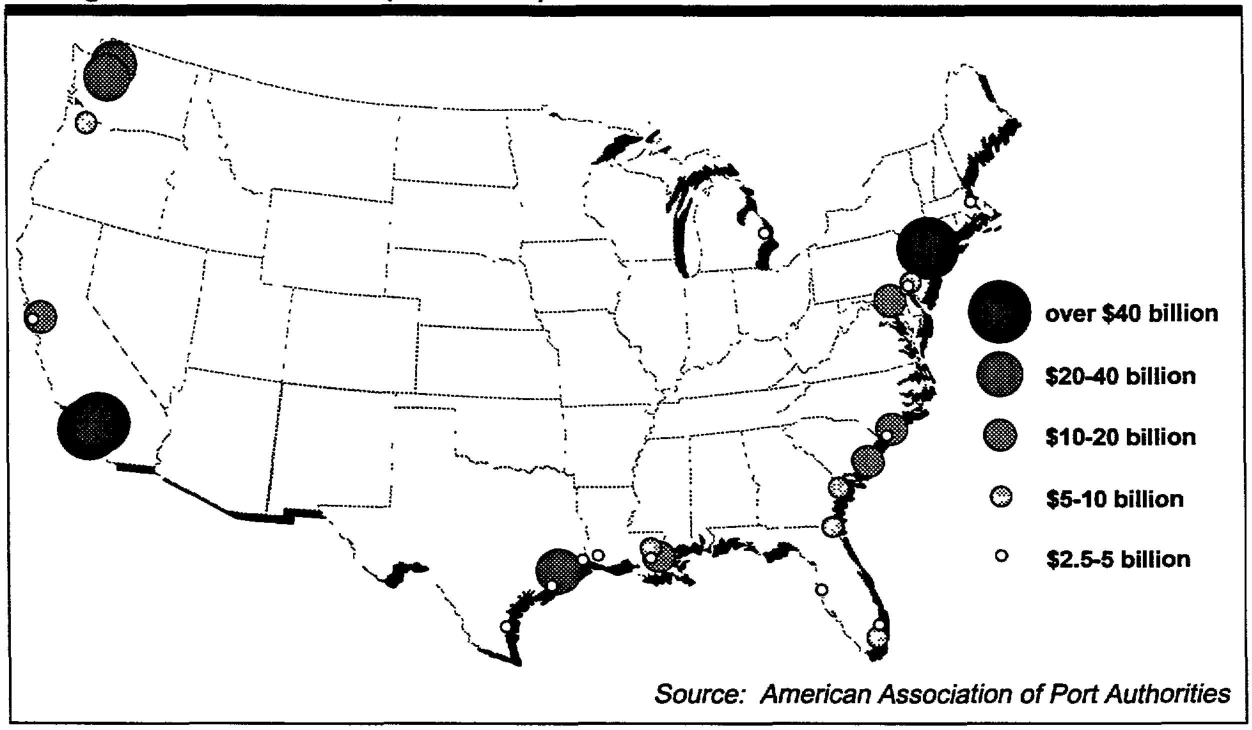
Source: Vickerman . Zachary · Miller

Cargo Throughput 1990 (in Short Tons)

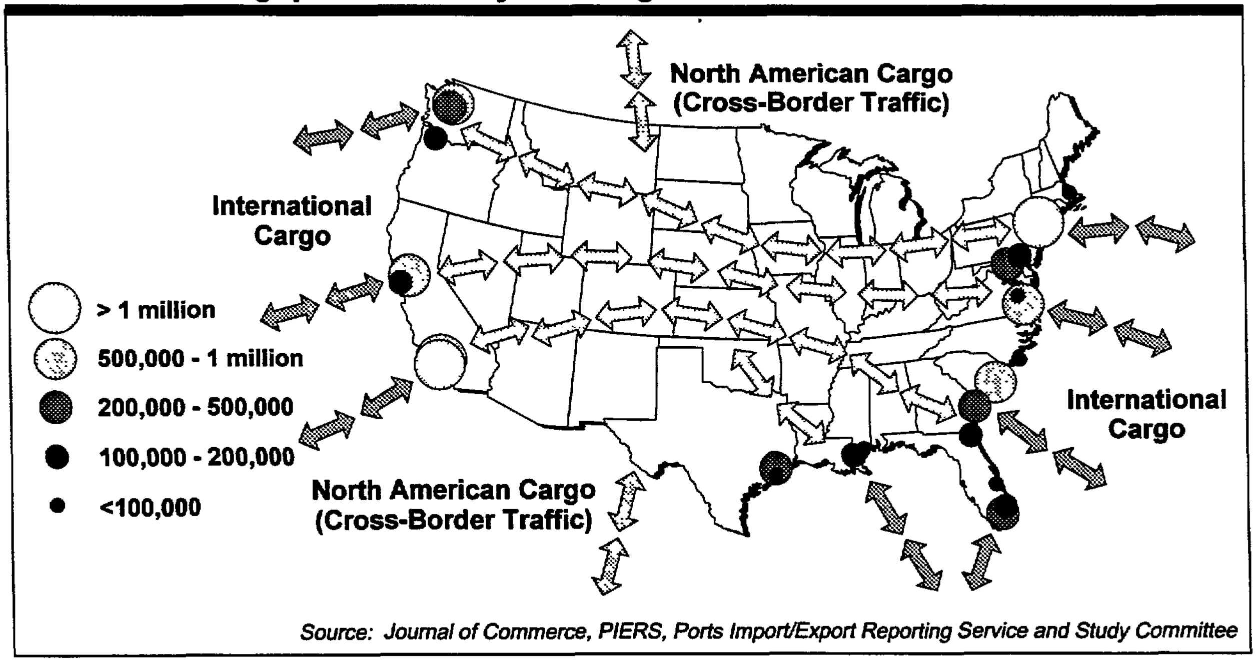


Source: American Association of Port Authorities

Foreign Commerce 1990 (in Dollars)



Container Throughput in TEUs by Port Region



Importance of water transportation:

Ocean-going vessels move over 95 percent of U.S. overseas trade by weight and 75 percent by value.

Source: U.S. Bureau of the Census

Economic Impact of Ports

- *Employment for 1.5 million Americans.*
- *Contributed $70 billion to the U.S. Gross Domestic Product.*
- *Personal income of $52 billion.*
- *Federal taxes of $14 billion.*
- *State and local tax revenues amounting to $5.3 billion.*

Source: U.S. Department of Transportation. Data is 1991

Customs Revenues

Ports produce the vast majority of U.S. Customs revenues through the import duties collected at ports – $11 billion in receipts in FY 1991.

Ports and National Defense

During Operation Desert Shield/Desert Storm, over two dozen public ports handled two-thirds of the military cargo, about 4.2 million tons, shipped to the Middle East. Deployment required over 312 vessels from 18 commercial and military ports in the U.S.

Source: U.S. Military Traffic Command

Changing Market Demand and Future Cargo Forecasts

The cost reductions made possible by widespread containerization and other improvements have led to dramatic growth for U.S. ports. TRB Special Report #238 notes:

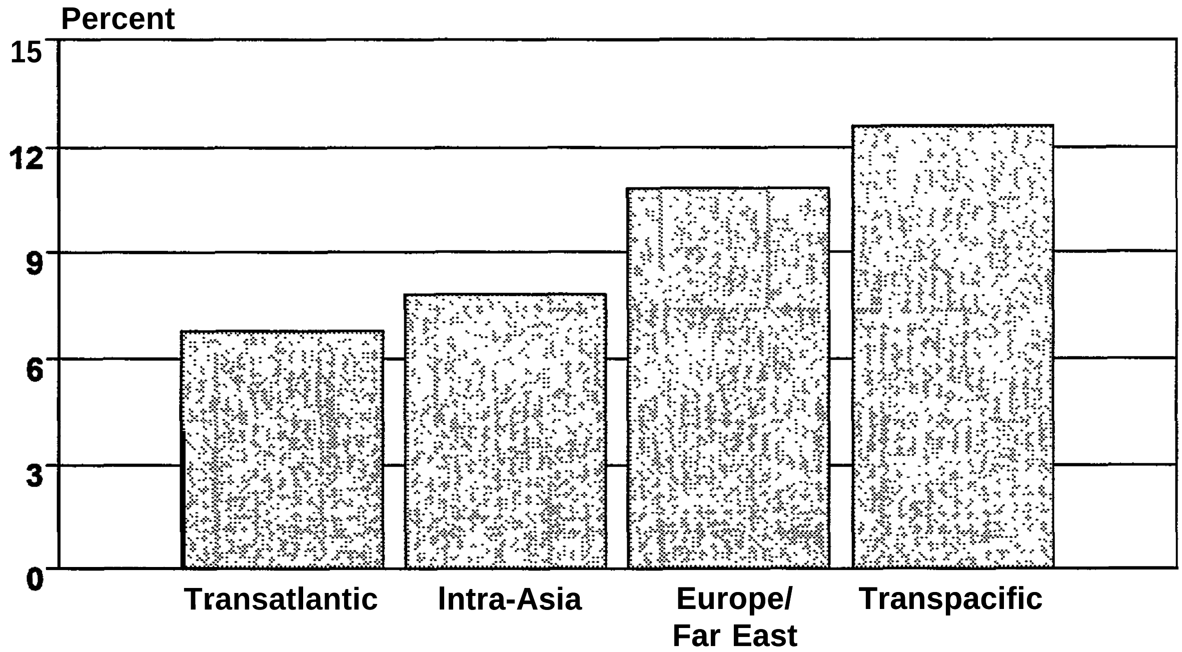
> "Over *the past 20 years, imports and exports have increased so that they equal one-fifth of the U.S. gross national product. U.S. seaports handled $50 billion in international cargo in 1990. These ports have become critical transfer points in the intermodal network that moves the nation's international cargo."*

Overall, tonnage moved through U.S. seaports is expected to triple over the next 30 years. Increasingly, world economies are becoming interdependent; and countries are actively pursuing international trade alliances. Explosive growth of production capacity in Southeast Asia, the anticipated opening of markets in China and Eastern Europe, stabilization and expansion of trade with Mexico and Central and South America and politics of international cooperation will contribute to this growth.

Another effect that appears to be emerging is increasing specialization of ports with respect to cargo-handling capabilities. Ports that are well suited to handle containers by virtue of local market size, intermodal connections, water depth, infrastructure and other factors want to maximize their container throughput. Because container terminals are land-intensive, this involves acquiring new land and/or redeveloping existing land. In some cases, non-container terminals are eliminated, and these must relocate to other ports. The non-container ports, in turn, see the chance to fill a market void and pursue these opportunities aggressively. This effect is seen to different degrees at different ports and tends to impact commodities that do not require extensive capital investment in their facilities (such as automobile, steel or lumber terminals)-it is more expensive and less practical for major liquid or dry bulk facilities to be relocated, although it is occurring with increasing frequency

What does this mean in terms of landside access? If the largest U.S. ports can expect dramatically increased cargo volumes both from overall growth in trade and increased specialization and if smaller ports can expect to share in this growth, the result will be a dramatically increased demand for access. Large established ports in urbanized areas, with aging infrastructure and constrained dimensions, find their systems overburdened. Smaller or emerging ports are discovering the downsides- impacted neighborhoods, blocked grade-crossings and clogged two-lane roads--of gaining their "fair share" of the market.

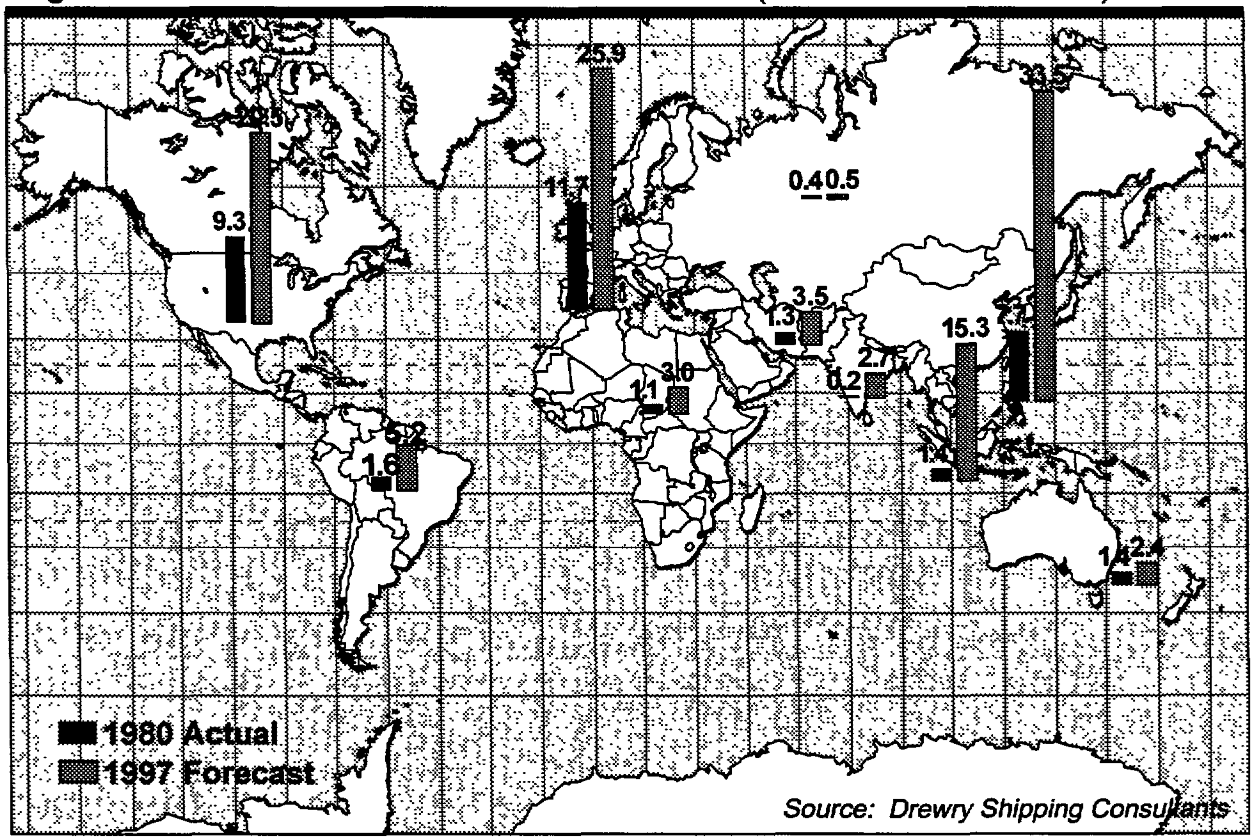
High Volume Growth Over the Past Five Years



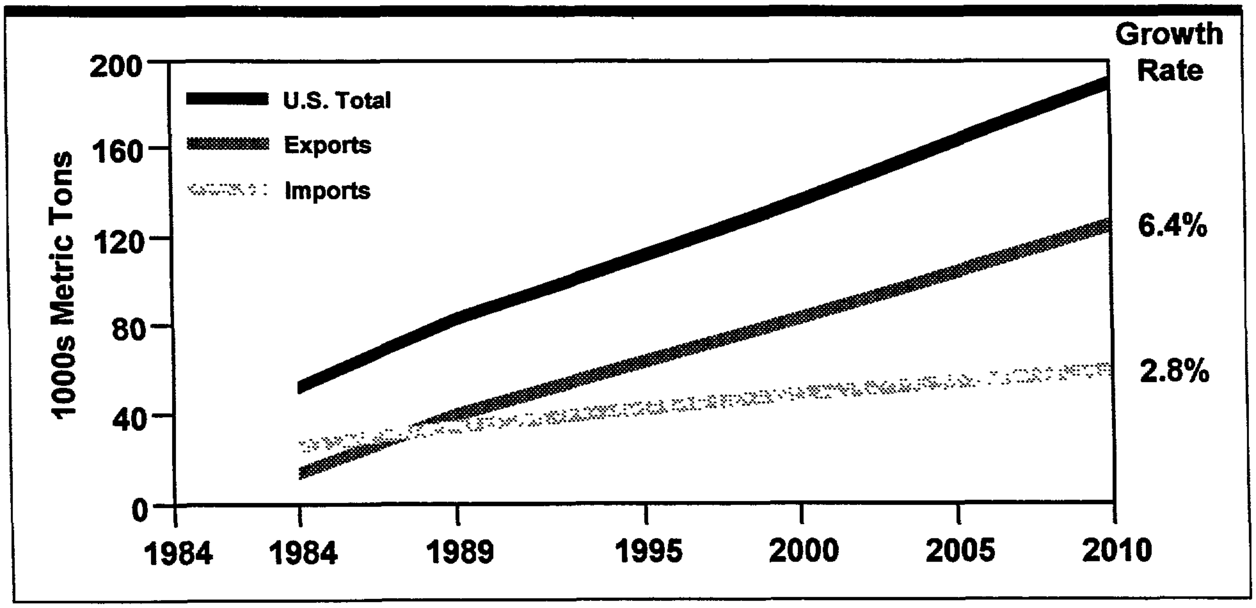
Source: TBS/DRI World Trade Service, 1989

Ports are attempting to deal with this in a number of ways. One trend has been an increased aggressiveness on the part of ports in seeking transportation improvements- - lobbying their MPOs and DOTs, becoming involved in transportation funding policy-making, participating in cost-sharing agreements and even, in some cases, funding entire projects to improve roads, bridges and terminal gate complexes. A second and equally important trend has been to attempt to shift the transportation burden from highways to other modes, such as rail. A third trend is an increased willingness to look to future-oriented concepts, such as automated container trains or overhead conveyors that would allow storage yards to be located far inland, where truck impacts would be less significant, and long-distance slurries that would replace over-the-road hauling of dry bulk products.

Regional Growth of Container Traffic 1980 – 1997 (In million TEUs handled)



Total U.S. Containerizable Seaborne Trade Growth



Recent 1992 U.S./Latin American/Caribbean Trade Gains

- *U.S. trade jumped 321/2%.*
- *U.S. exports grew by 20%.*
- *U.S. imports grew by 5.7%.*
- *This equates to a $1.8 billion surplus in the U.S. trade balance (last year = $ 1 6 billion deficit).*
- *Trade relationships are stronger and more stable.*

Source: First Quarter 1992 U.S. Department of Commerce Statistics

Cuban Containerized Trade Outlook

Future

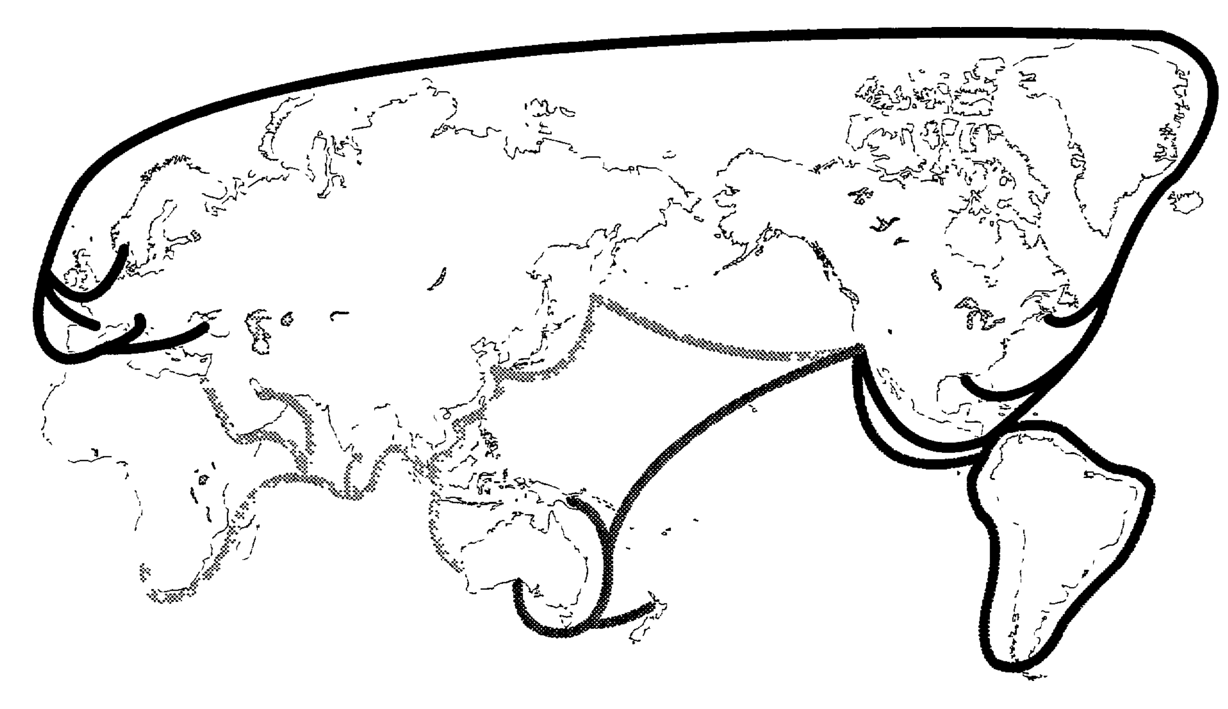
- *U.S. Congress has proposed to overturn 32-year U.S. Trade Embargo (Cuba Democracy Act).*
- *international pressure to open trade with Cuba.*
- *Cuba's move away from a single-product economy (sugar).*
- *Tourism, Cuba's fastest growth sector, is a rising star: tourism jumped 30% in 1992 to $400 million.*
- *Cuba's government recently approved state and foreign business joint ventures.*

Source: Vickerman · Zachary · Miller

Vessel Evolutionary Pressures and Deployment Strategies

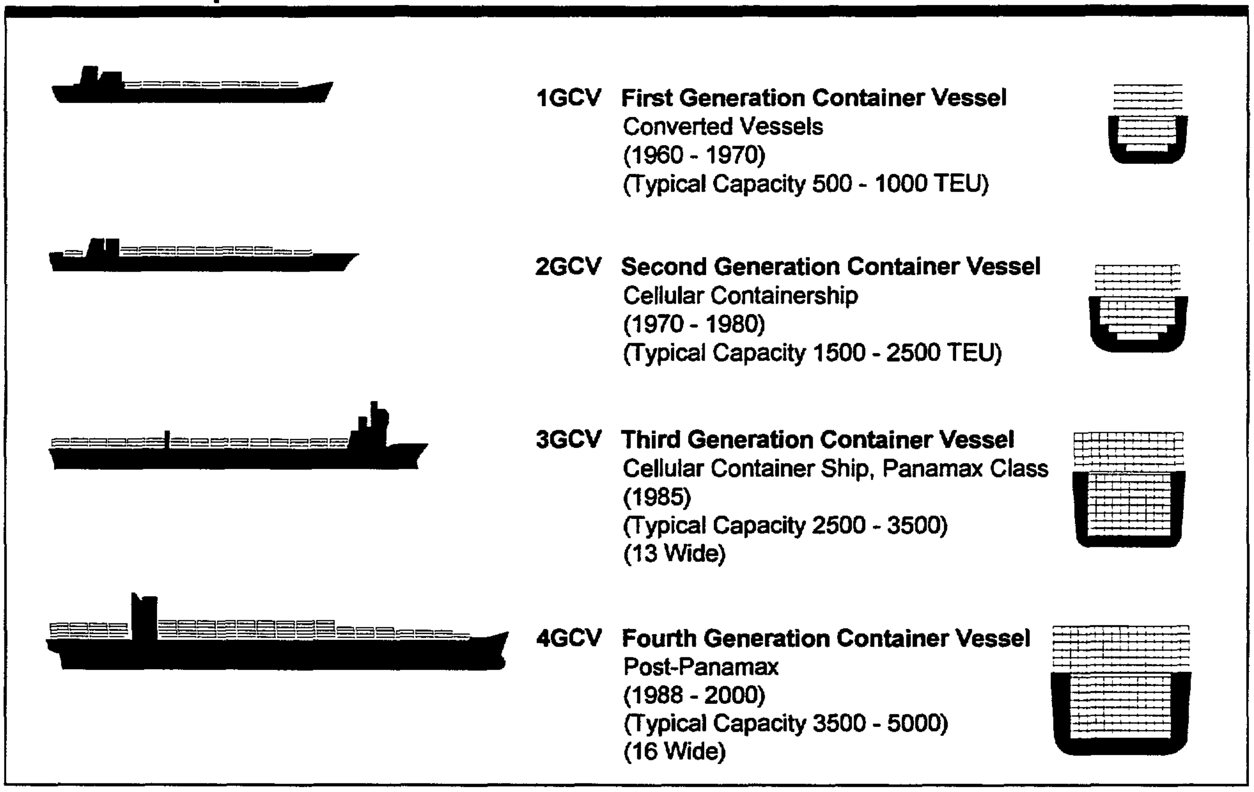
A number of interesting trends can be observed in terms of vessel size and deployment. Ships are getting larger, taking advantage of economies of scale. This makes them more expensive to build and operate, requiring faster turnaround times at ports to keep them in service. Larger and faster cranes have been developed in response. The increased use of landbridge strategies makes it more feasible for Southeast Asian services to run "backwards" through the Suez canal to the East Coast, rather than via the Pacific to the west coast.

Trade Routes

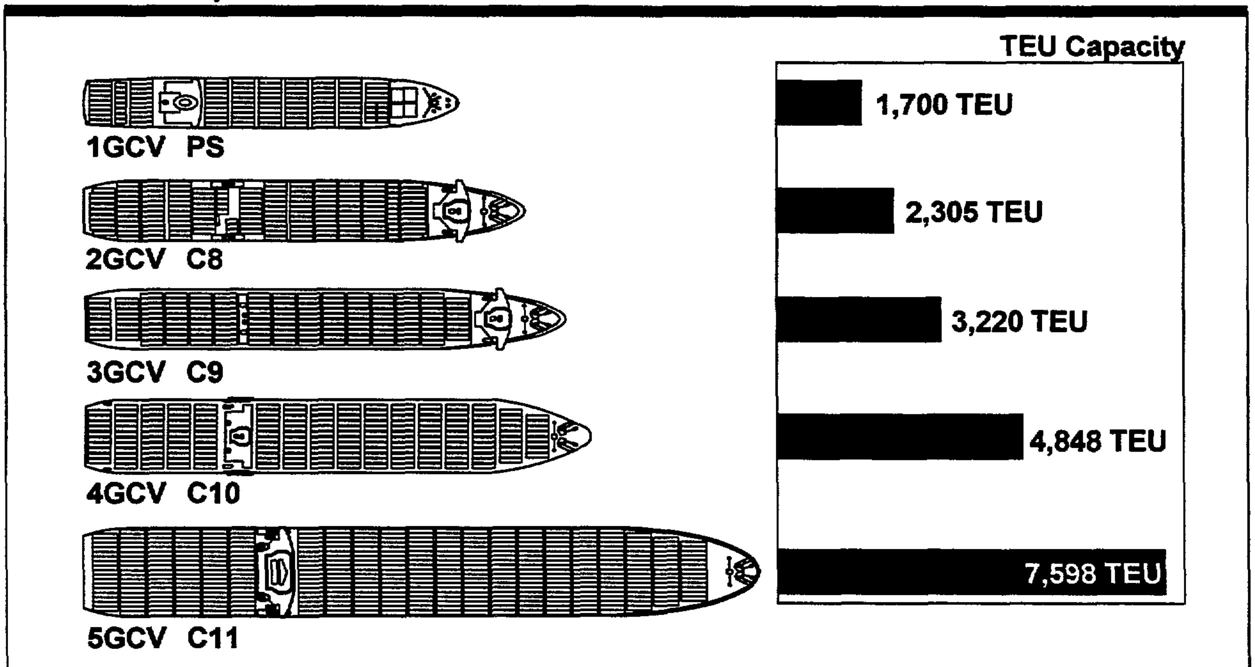


Source: Vickerman . Zachary . Miller

Container Ship Evolution

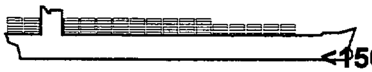


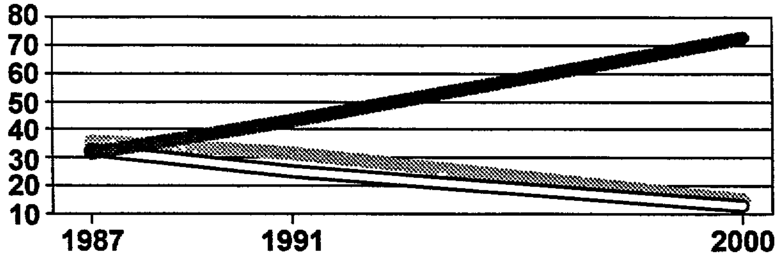
Container Ship Evolution



Source: Vickerman · Zachary · Miller

Full Cellular Container Vessel World Fleet Size Trends

Vessel Size	1987	1991	Asian Only 2000	Trend
 <1500 TEU	35.7%	31.7%	15.1%	↓
 1500 – 2000 TEU	32.7%	25.2%	12.7%	↓
 >2500 TEU	31.6%	43.1%	72.3%	↑



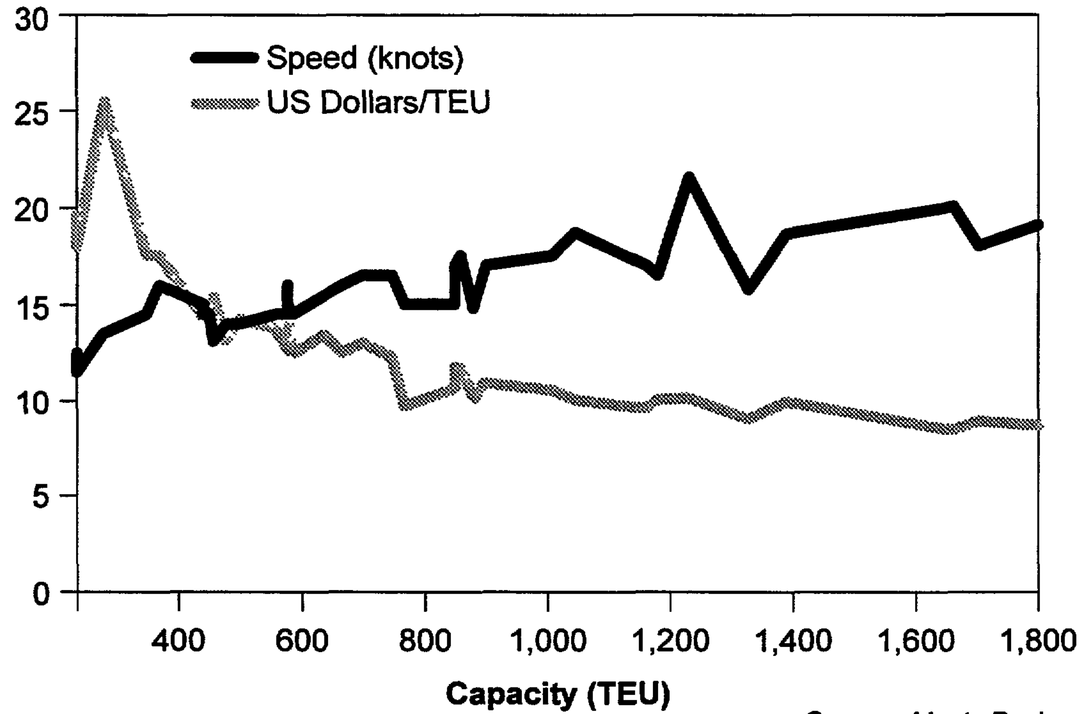
Source: ESCAP/UNDP MPPM 1992

Current Post-Panamax Vessel Population

Shipping Line	Existing		On Order		Total
	No Vsls	TEU	No Vsls	TEU	Number
American President Lines	5	4340	6	4800	11
CMG	1	4419			1
COSCO			6	5200	6
Evergreen			5	4900	5
Hanjin			4	4970	4
Hyundai Merchant Marine	6	4469	9	5046	15
Maersk			9	4800	9
MISC	1	4469	1	4469	2
Mitsui OSK			5	4800	5
Nedlloyd	2	4421			2
NYK	1	4800	2	4800	3
OOCL			6	4950	
Totals	**16**		**53**		**69**

Source: Port Authority NY/NJ, January 1995

Container Ship Efficiency



Source: Mentz Decker & Co.

The Newest Post-Panamax Container Vessel by Hyundai Merchant Marine

5 – 4,411 TEU Container Ships in '93 (Pacific Based)

11 – 4,411 TEU Container Ships in '97 (3 Lane Pendulum Service)

Speed 25.5 Knots; 70,330 bHp Diesel; 129 Ft. Beam
"Most powerful single-engined merchant vessel in the world."

Source: Container News, October 1992

Cosco has Ordered *the Largest Post-Panamax Container Ships Yet*

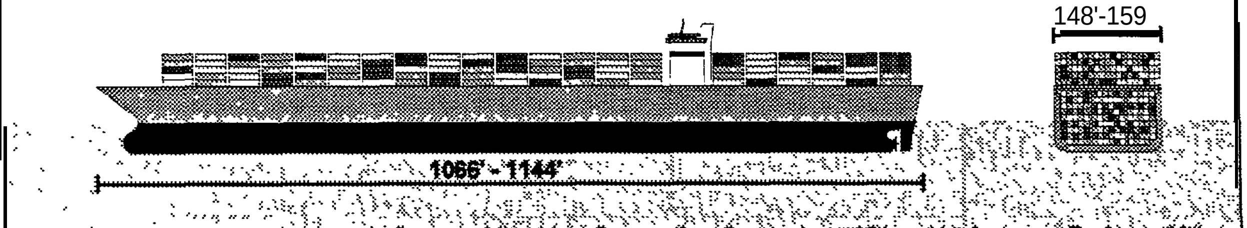
- *Six Vessels with 5,250 TEU Capacity*
- *$84 Million per Ship ($500 Million Total)*
- *Delivery: Late 7996 through 7997*
- *Service Speed: 24.5 Knots*
- *Deployment: Transpacific or Europe1 Asia Liner Service*

Source: Containerisation International, February7995

Future Container Ship Characteristics

(Estimate Based on Structural Considerations of
Maximum 9-High Container Stack in Hold)

Vessel Characteristics	8'-6"/9'-6 Container Mix	High-Cube Containers Only
Length Between Perpendiculars	1,066 ft.	1,144 ft.
Length Overall	1,132 ft.	1,210 ft.
Beam	148 ft.	159 ft.
Depth	82 ft.	88 ft.
Draft	44 ft.	45 ft.
TEU Capacity	6,795 TEUs	7,598 TEUs
Dead Weight Tonnage	78,000 T	87,000 T

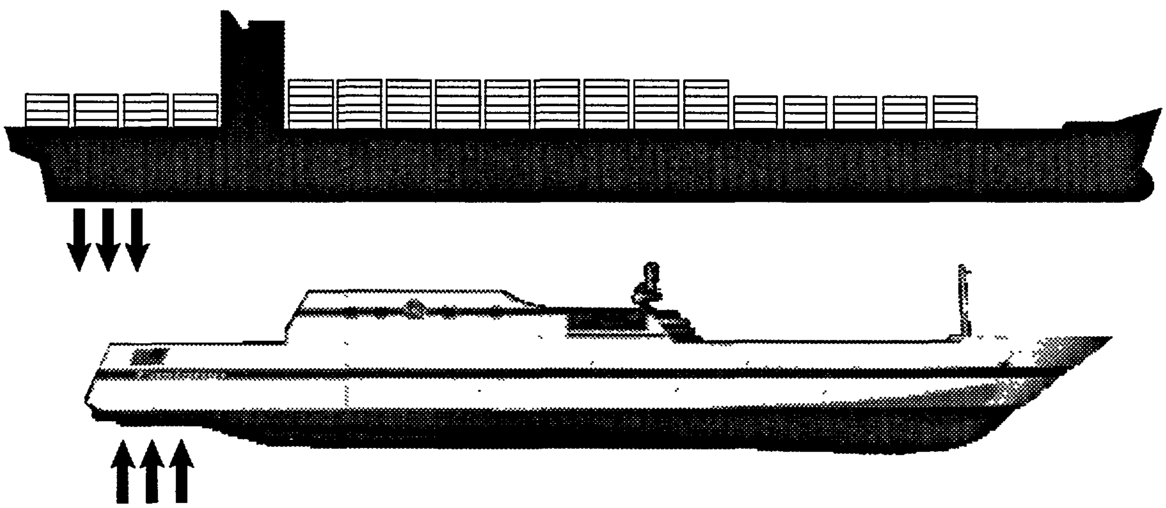


Source: Mitsubishi Corporation, September 1991 and Vickerman - Zachary - Miller

"Techno-Superliner" Highlights – Japan's Fast Cargo Vessel Research Project

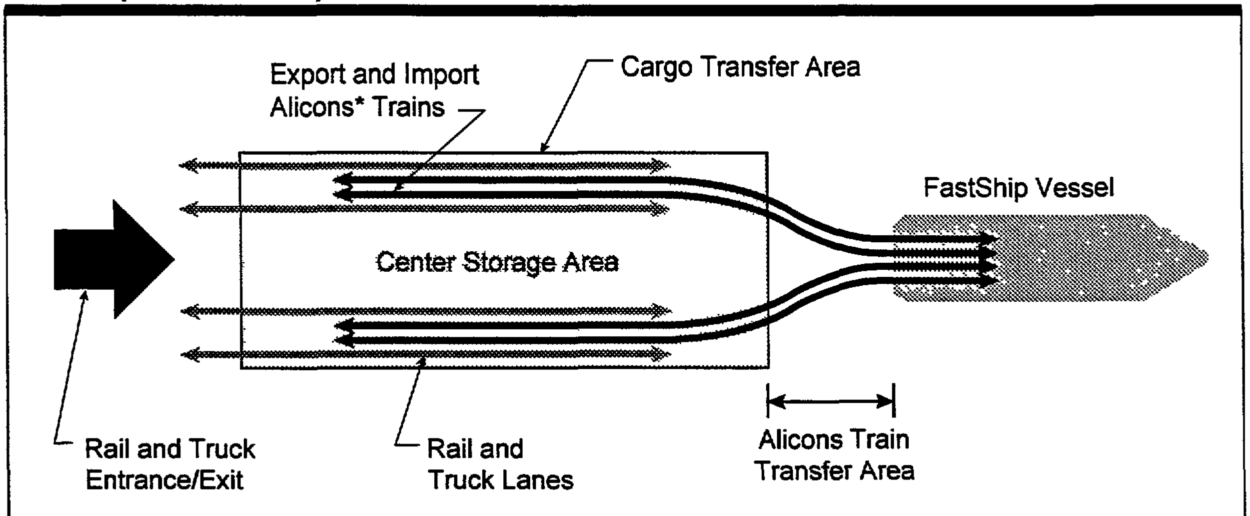
- *Built to aircraft standards.*
- *Semi-submerged craft (SSC) technology — trimaran hull.*
- *$11 million research including Japanese Ministry of Transport plus seven Japanese shipbuilders.*
- *Scale prototype 1997.*
- *50 knot speed, range: ?; TEU capability: ?.*

FastShip Patented Technology



SPM Hull Design **Gas Turbine** **Water Jet**

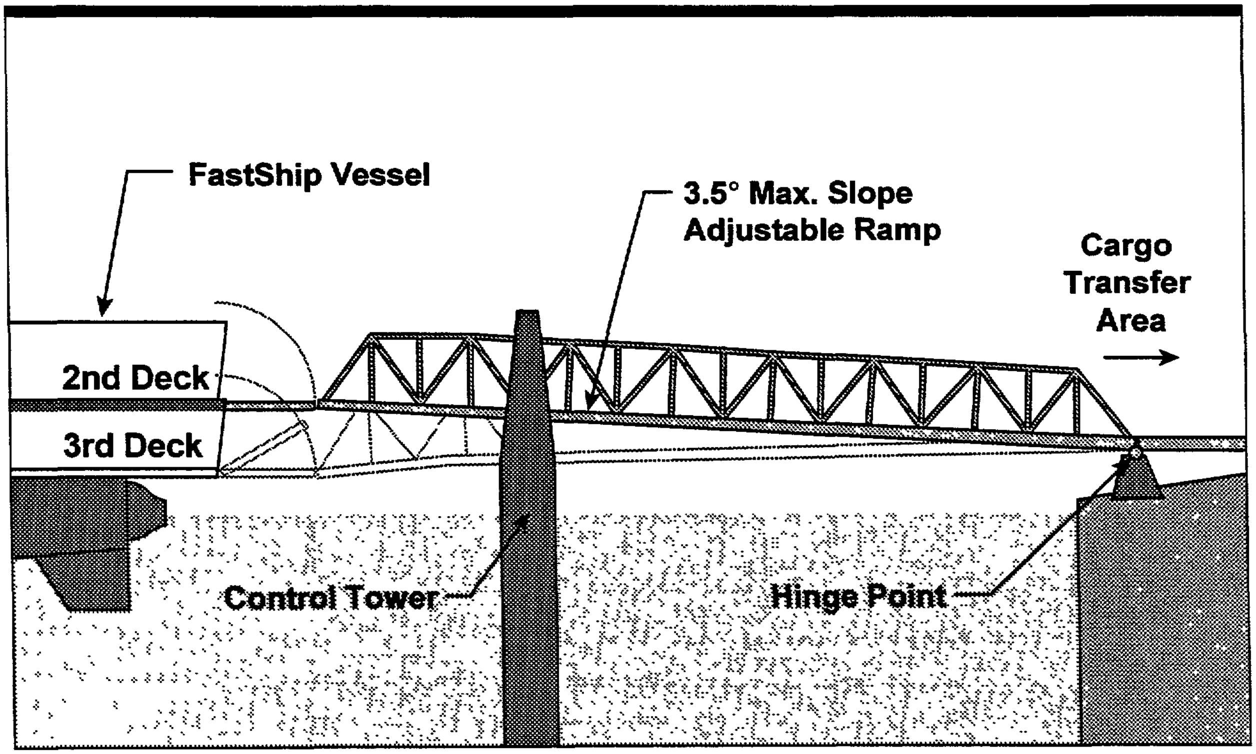
FastShip Terminal Operations



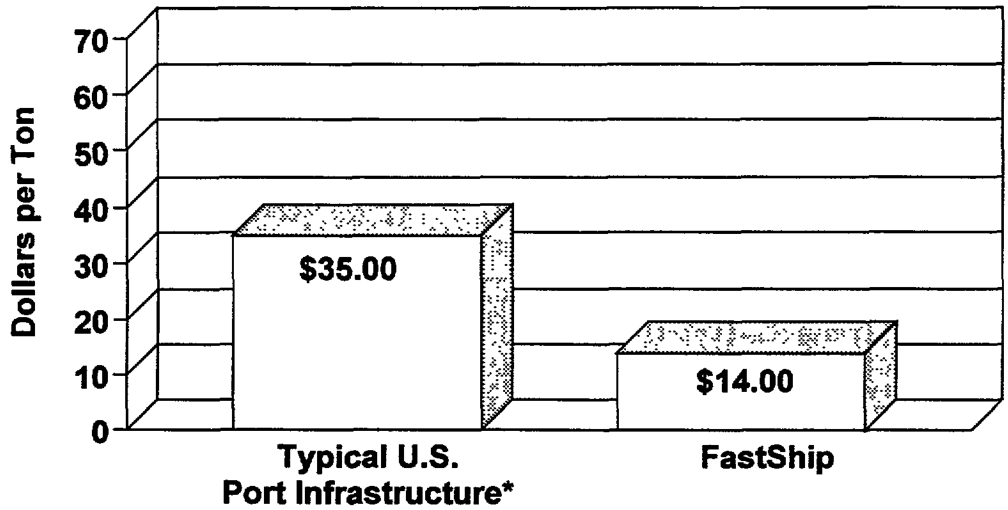
*Airlift Container System

Source: Vickerman · Zachary · Miller

FastShip Link-Span Section



Capital Costs per Ton of Throughput



*Assumes one million dollars per acre, 2,500 to 3,000 TEUs per acre and 10 tons per TEU

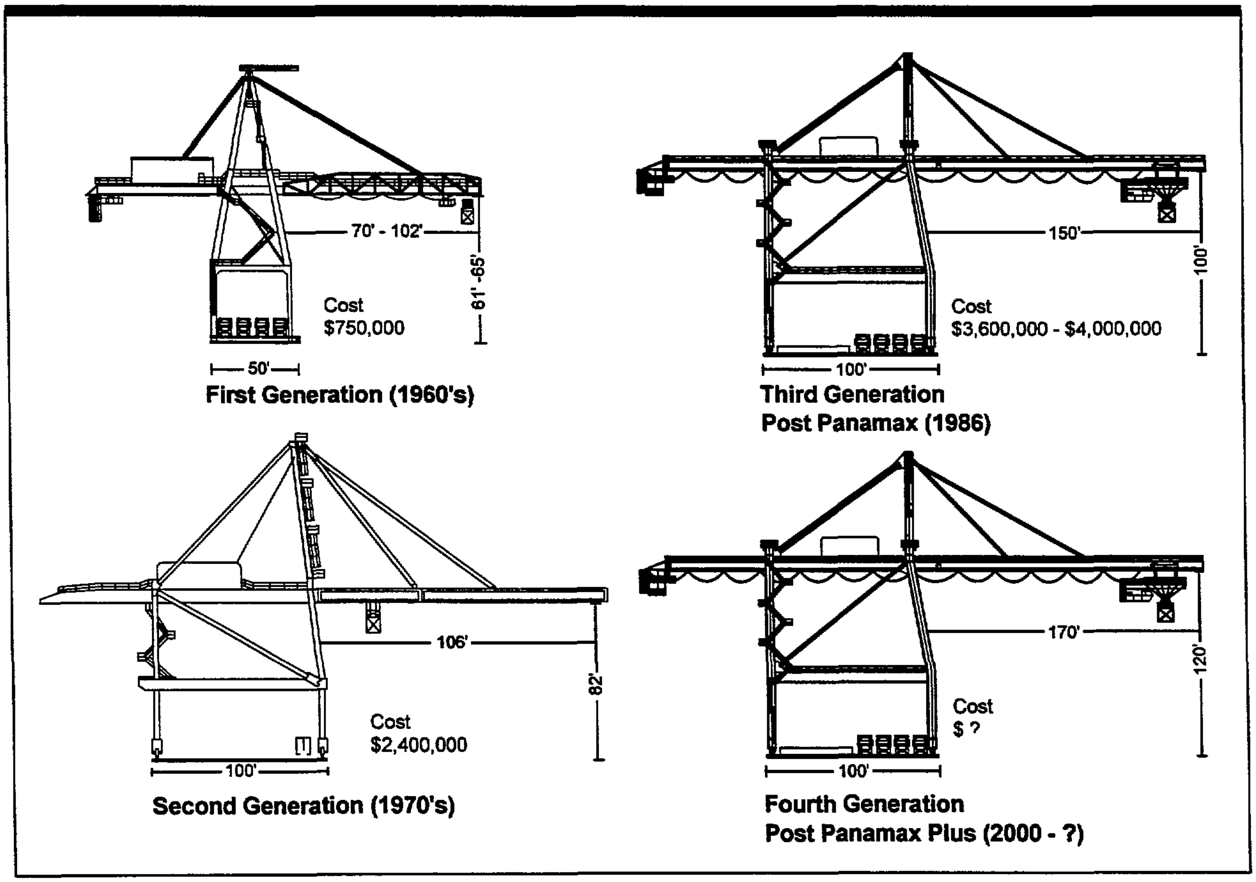
Fastship Service Characteristics

- *Ocean Speed: 45 Knots (37 Operational)*
- *Payload: 10,000 Tons/2 Million Cubic Ft.*
- *Design: Monohull, "Semi-Planing" (SPMH)*
- *DWT: 30,000 Tons*
- *Propulsion: 2-GE LM6000 Marine Gas Turbines (CF6 Aircraft Engines with Marine Diesel or LNG Fuel)*
- *High Seakeeping Capability: 40 Knots, 95% North Atlantic Weather with Waves to 20 Ft.*

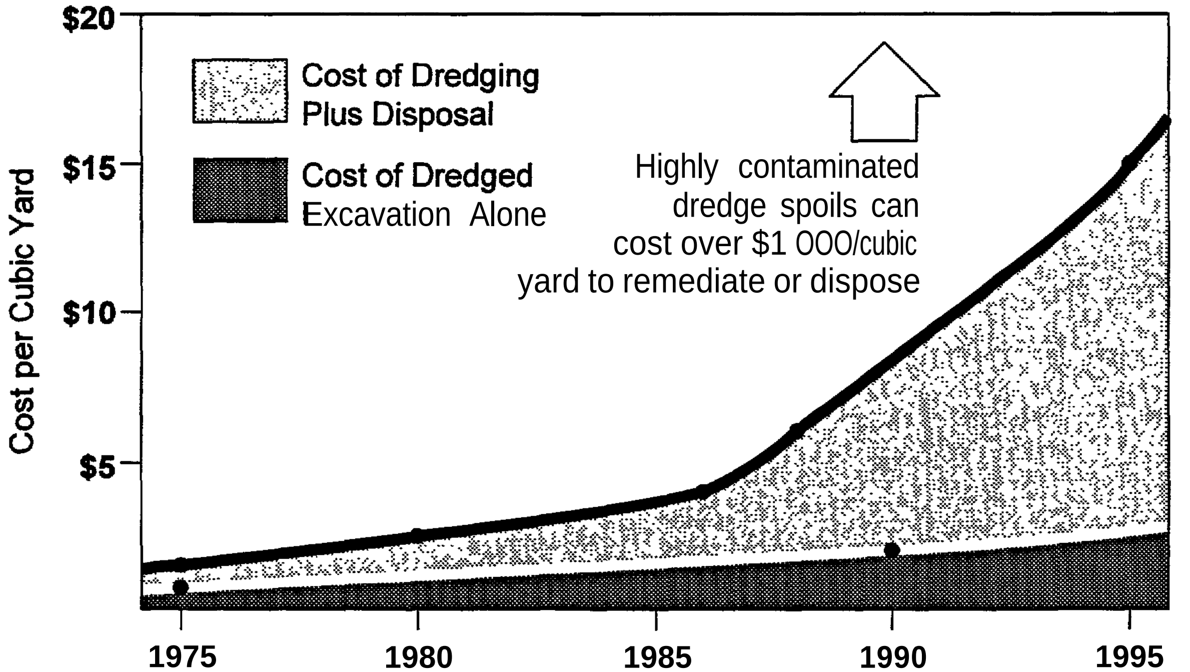
Fastship Service Characteristics

- *Transatlantic Time: 31/2 Days (6 – 8 Usual) Transpacific Time: 41/2 Days (10 Usual)*
- *Asia – Europe Door-to-Door Delivery: 2 Weeks (4 – 8 Weeks Usual)*
- *Market: HVTS (High Value Time Sensitive)*
- *50 Fastships Could Transport All the Non-Bulk Supplies for Operation Desert Storm in the Same Time as it Took the 213 Conventional Ships Using 91 Foreign Flag Vessels*

Crane Evolution

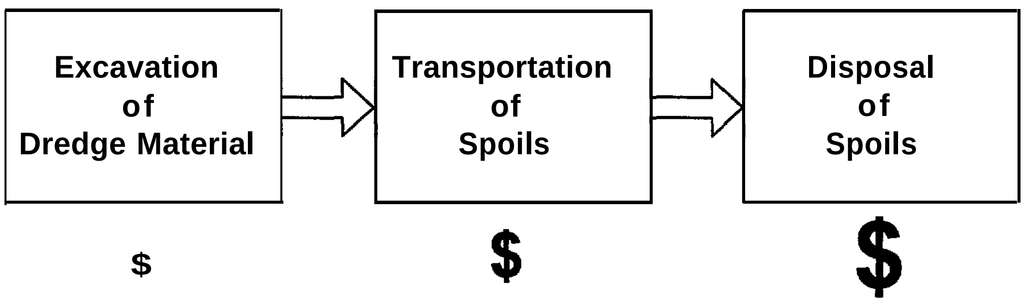


Increased Cost of Dredging and Disposal



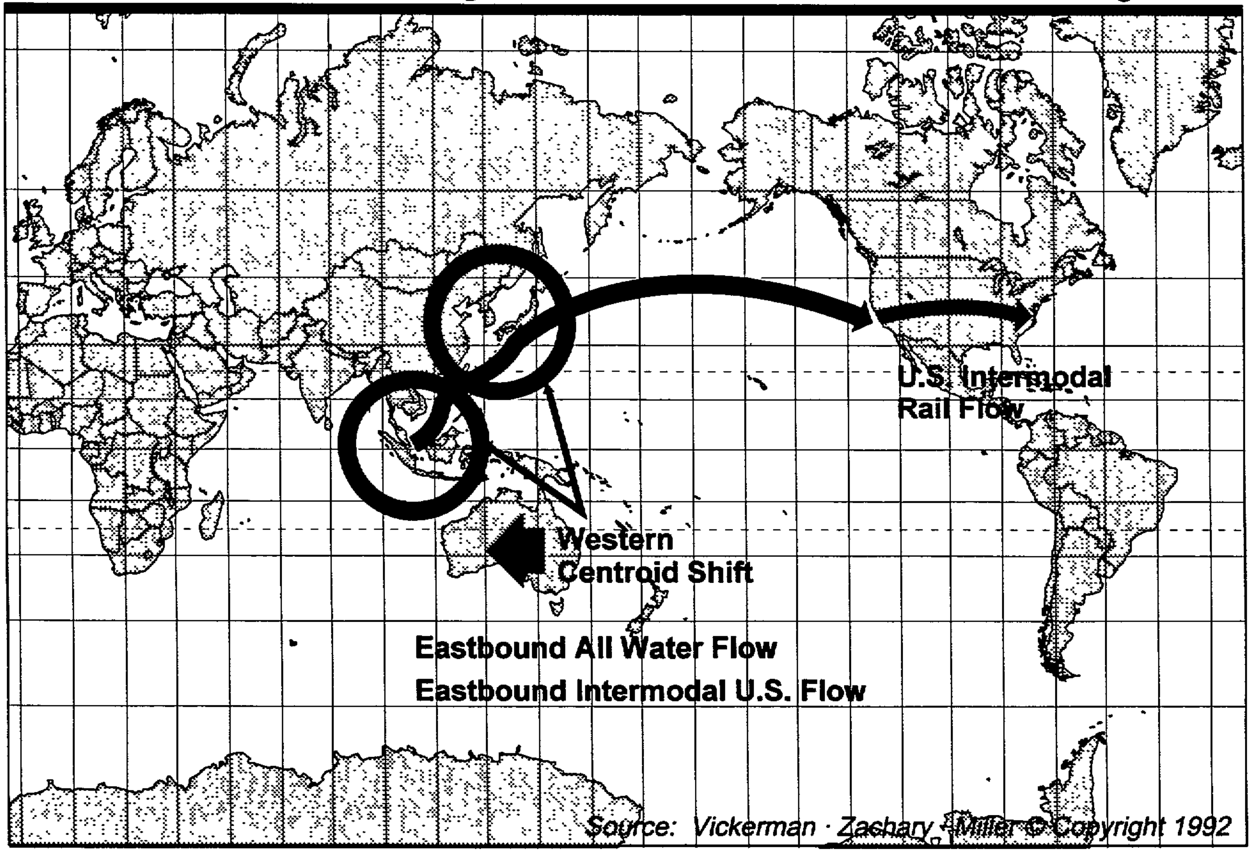
Sources: EIS Final Supplement: Oakland Harbor Deep Draft/Navigation Improvement, 1988; Final EIS for Maintenance Dredging, San Francisco Bay, 1975: LTMS, Winter 1990 Update

A Typical Navigational Dredging Event* Includes:

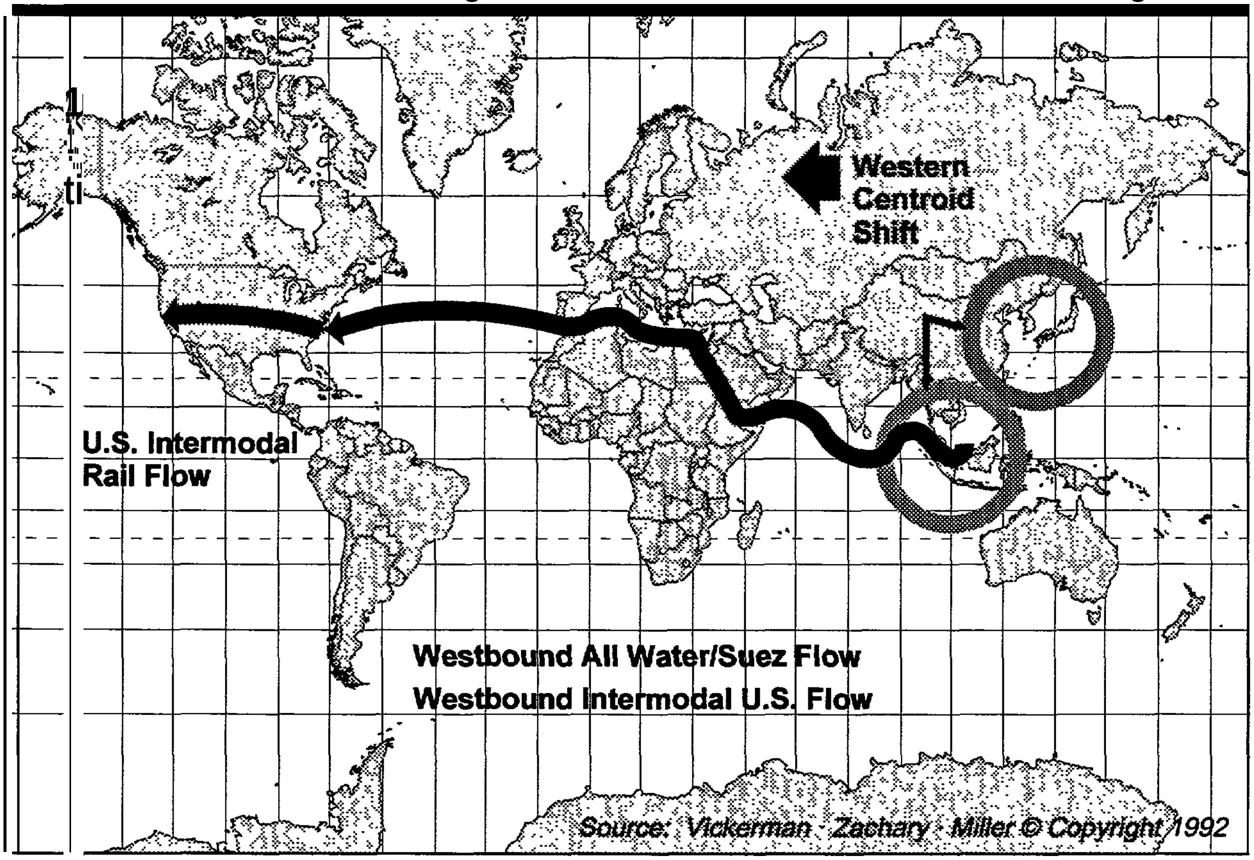


* (1 Million Cubic Yards = 50,000 Dump Trucks)

Southeast Asian Manufacturing Centroid Shift – Current Inbound U.S. Cargo Flow



Southeast Asian Manufacturing Centroid Shift – Reverse Inbound U.S. Cargo Flow



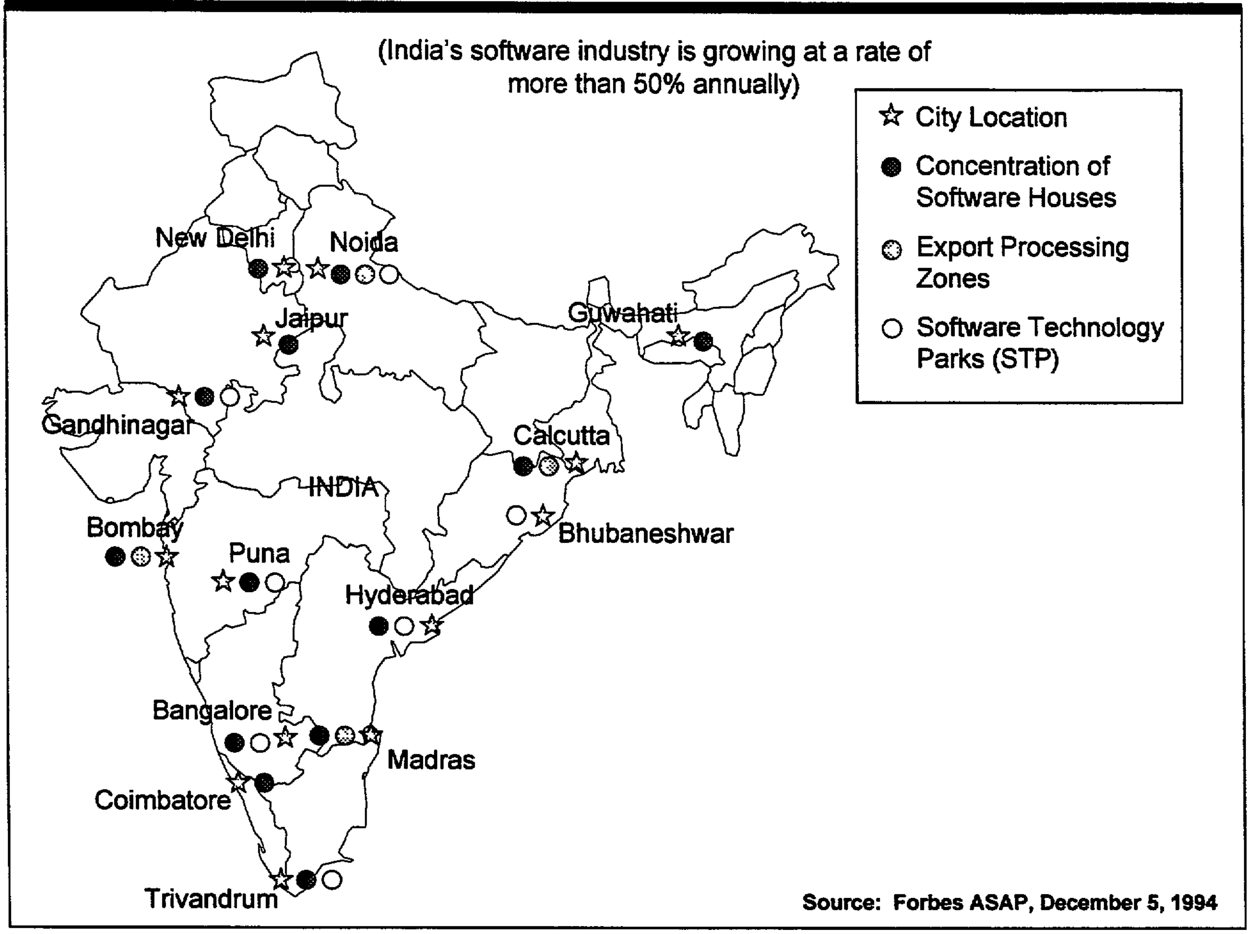
NOUNYK Asia — East Coast Express (AEX)

- *Direct Service from Singapore via the Suez Canal with Six-2,000 TEU Vessels*
- *10 Day Initial Sailing Frequency, then 7 Day Frequency*
- *Transit Time Comparisons:*

	Old via Panama	New via Suez	Time Savings
Singapore to New York	36 Days	22 Days	14 Days
Singapore to Charleston	32 Days	24 Days	8 Days
Singapore to Norfolk	34 Days	26 Days	8 Days

Source: Vickerman . Zachary · Miller

India's Information Technology (IT) Centers



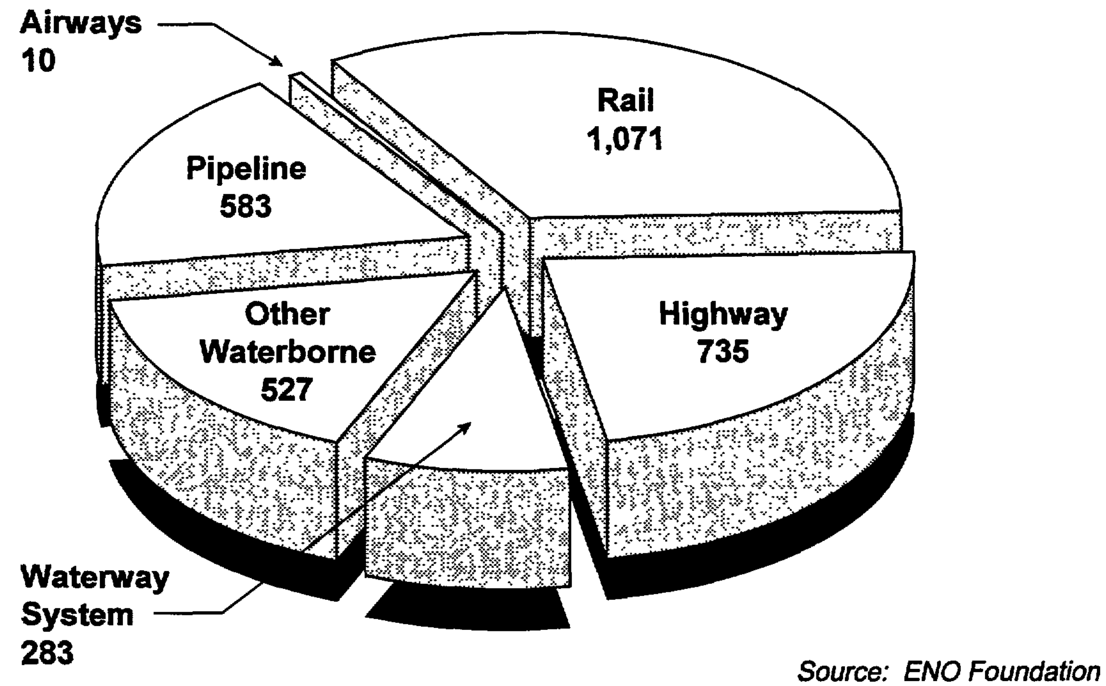
Inland Waterways

Characteristics of Inland Waterways

- *"Inland ports and terminals bring together highway, railway and pipeline modes of transportation" with the waterways.*
- *Except for pipeline, "Barge transportation remains the lowest-cost mode per ton-mile... For some commodities, the cost of intermodal transfers to or from the wet mode exceeds the cost of hundred of miles of transportation by barge.*

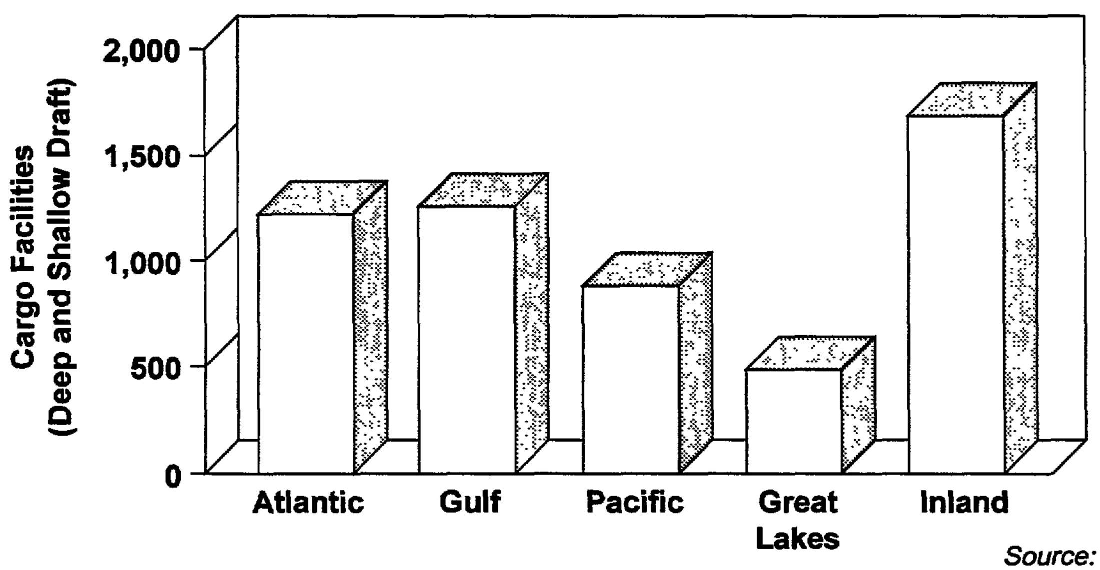
Source: Inland Rivers Ports and Terminals

Domestic Intercity Freight Traffic by Mode, 1990 (in billions of ton miles)



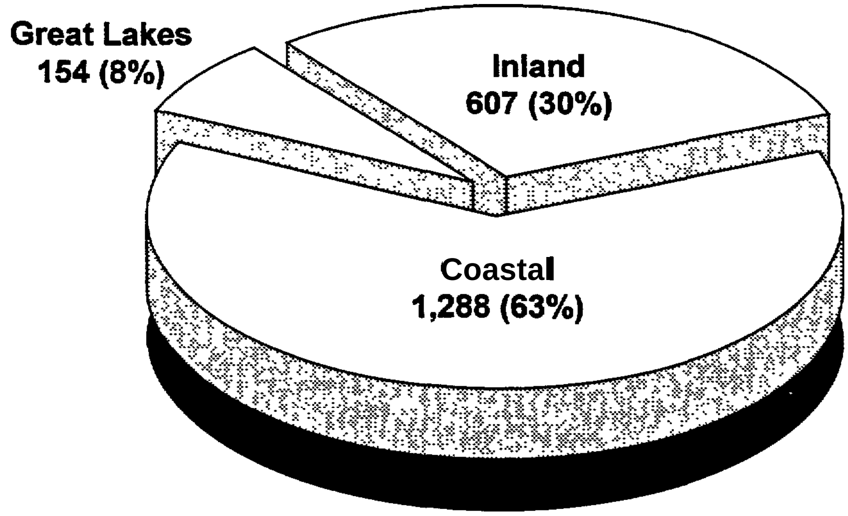
Source: ENO Foundation

Geographic Distribution of U.S. Waterway Facilities



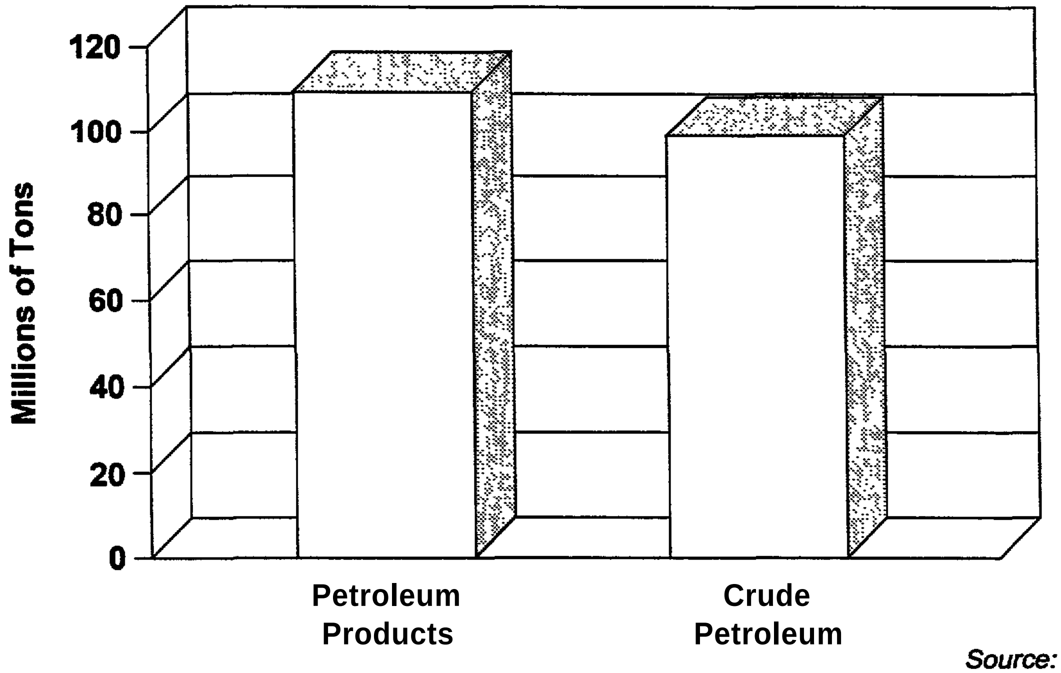
Source: ACOE

Geographic Distribution of U.S. Waterborne Activities in 1993
(Domestic and International, in millions of tons)



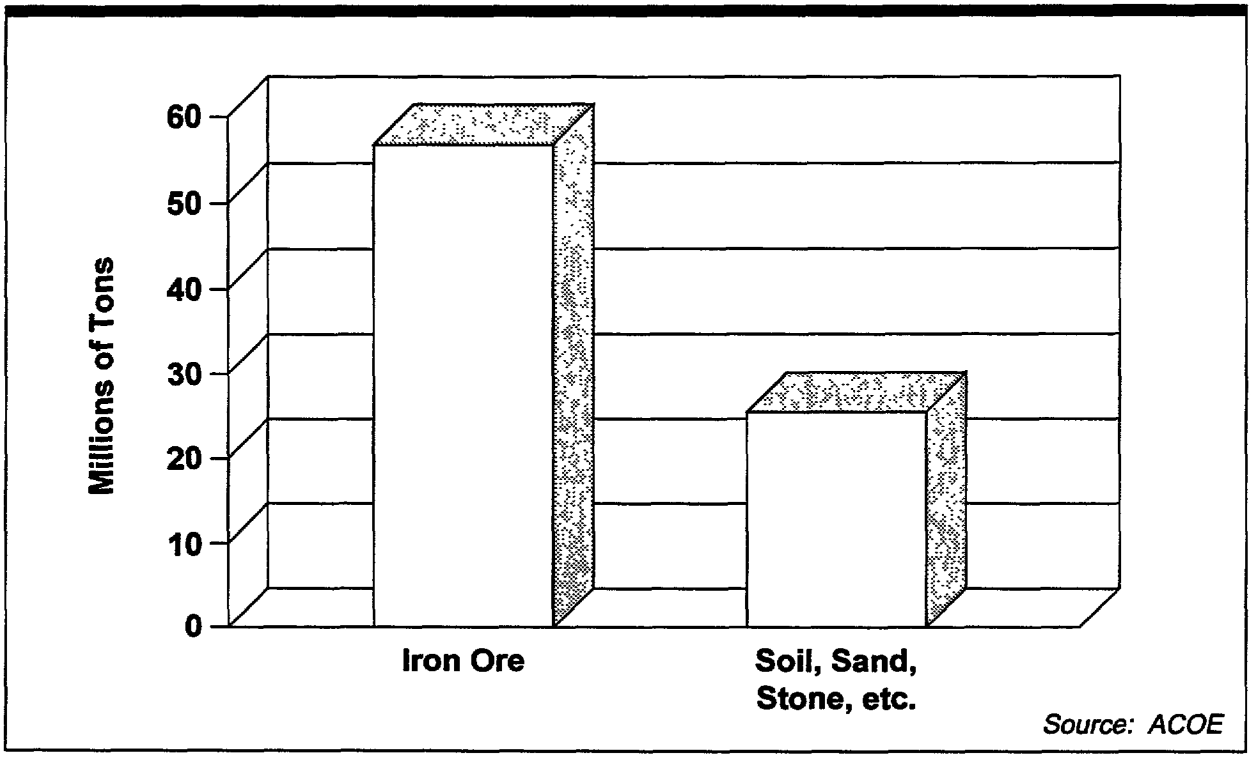
Source: ACOE

Coastal Moves – Commodity Volumes, 1993

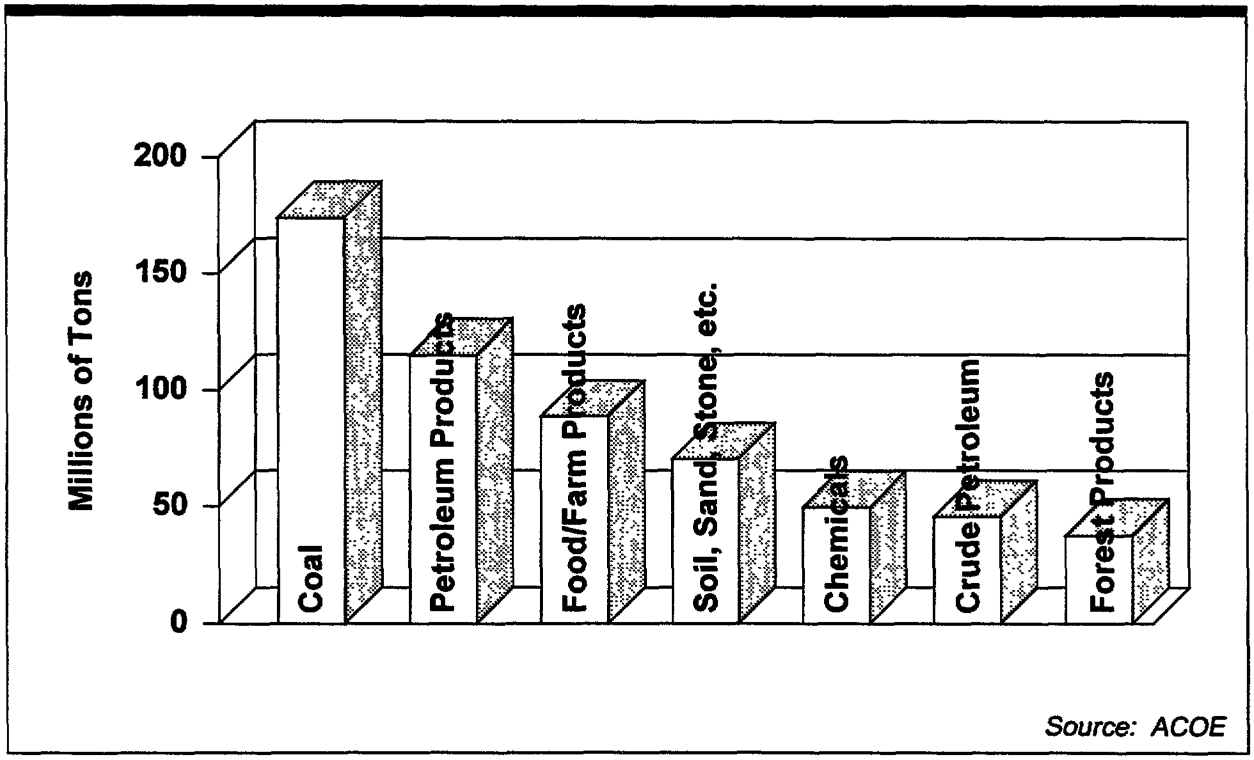


Source: ACOE

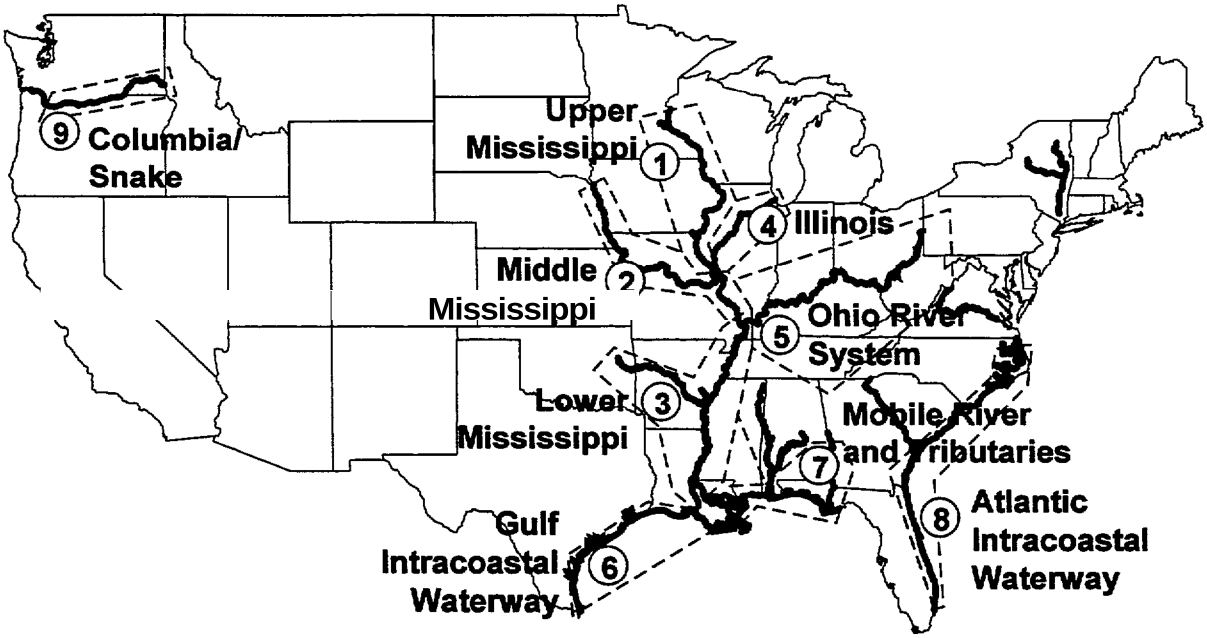
Great Lakes – Commodity Volumes, 1993



Inland Waterways – Commodity Volumes, 1993



Inland Waterway Segments



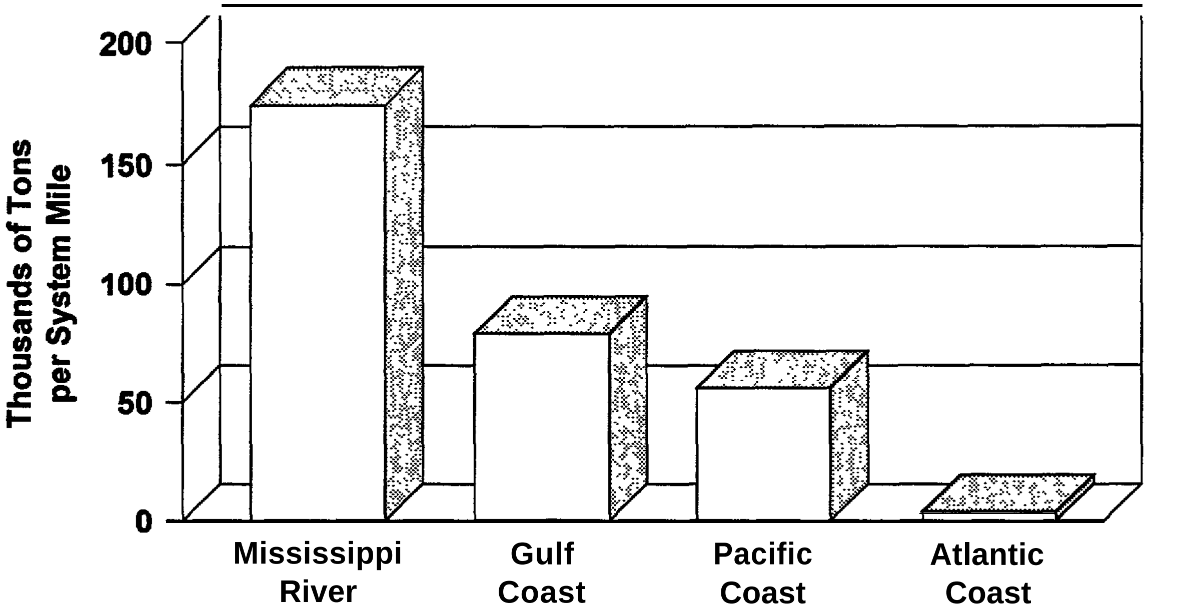
Source: ACOE

Domestic Traffic by Inland Waterway System, 1993

System	Components	Miles	Tons (millions)
Atlantic Coast	2	1,142	4.8
Gulf Coast	8	2,301	181.1
Mississippi River	16	8,229	1,434.8
Pacific Coast	3	722	40.4

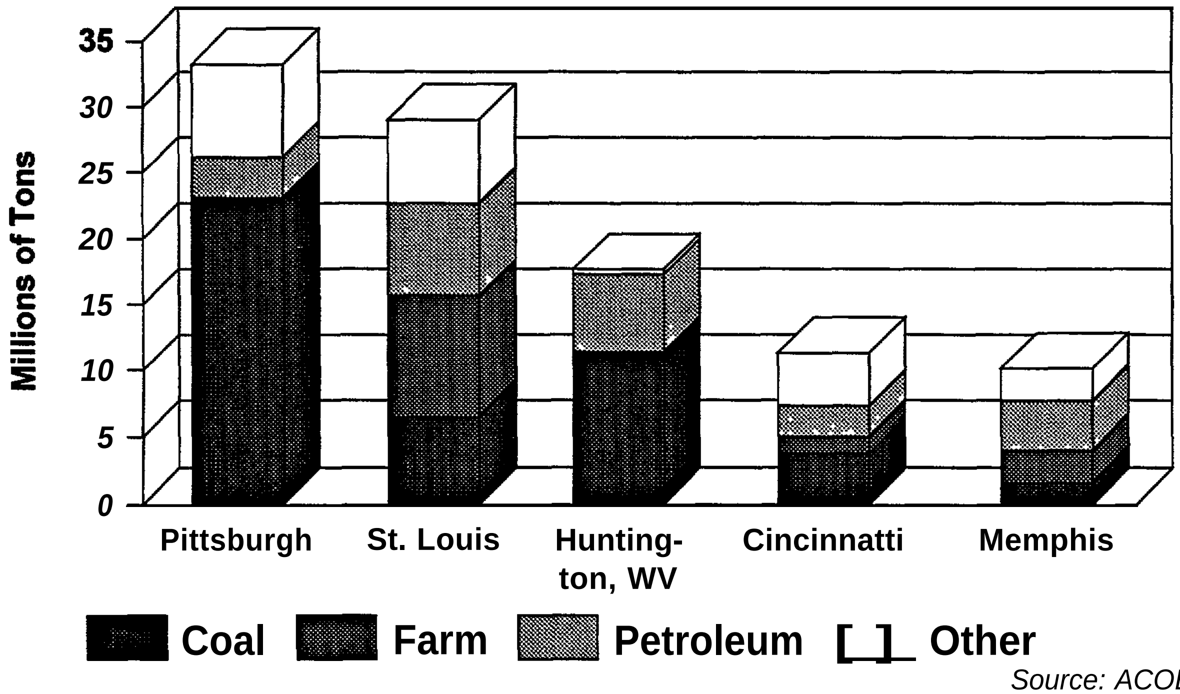
Source: ACOE

Inland Waterway System – Intensity of Use



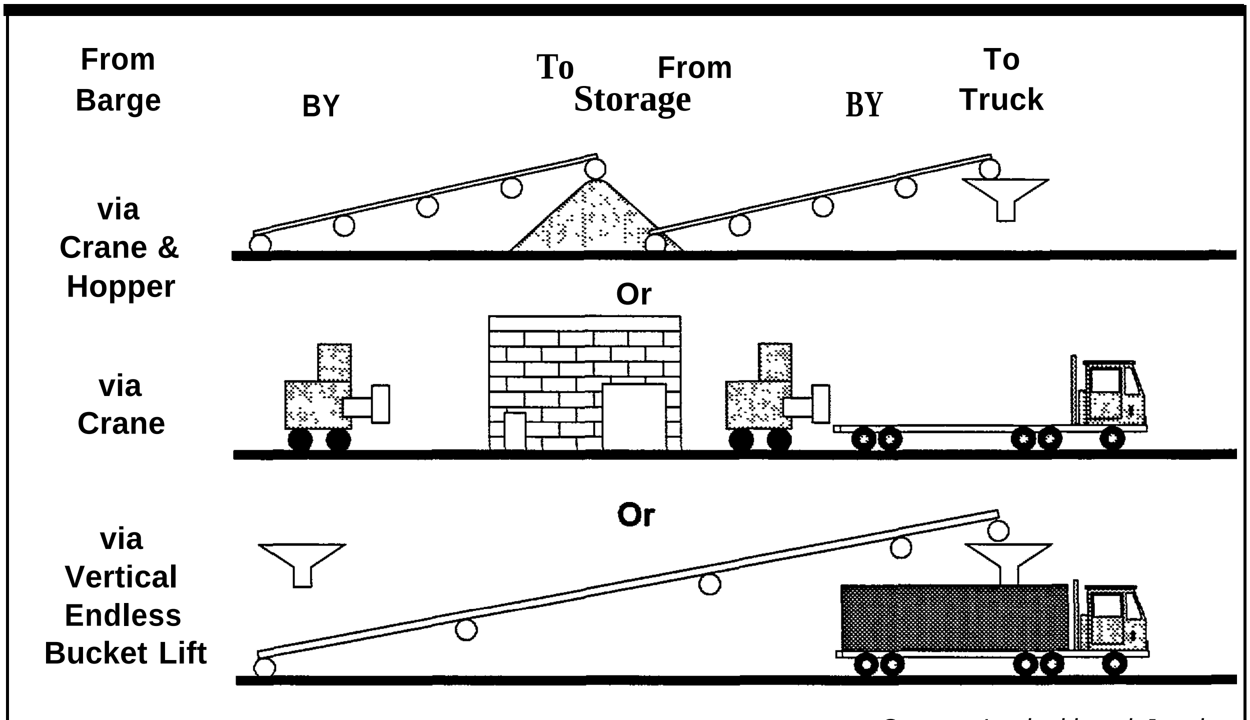
Source: ACOE

Tonnage of Leading Inland Ports, 1988



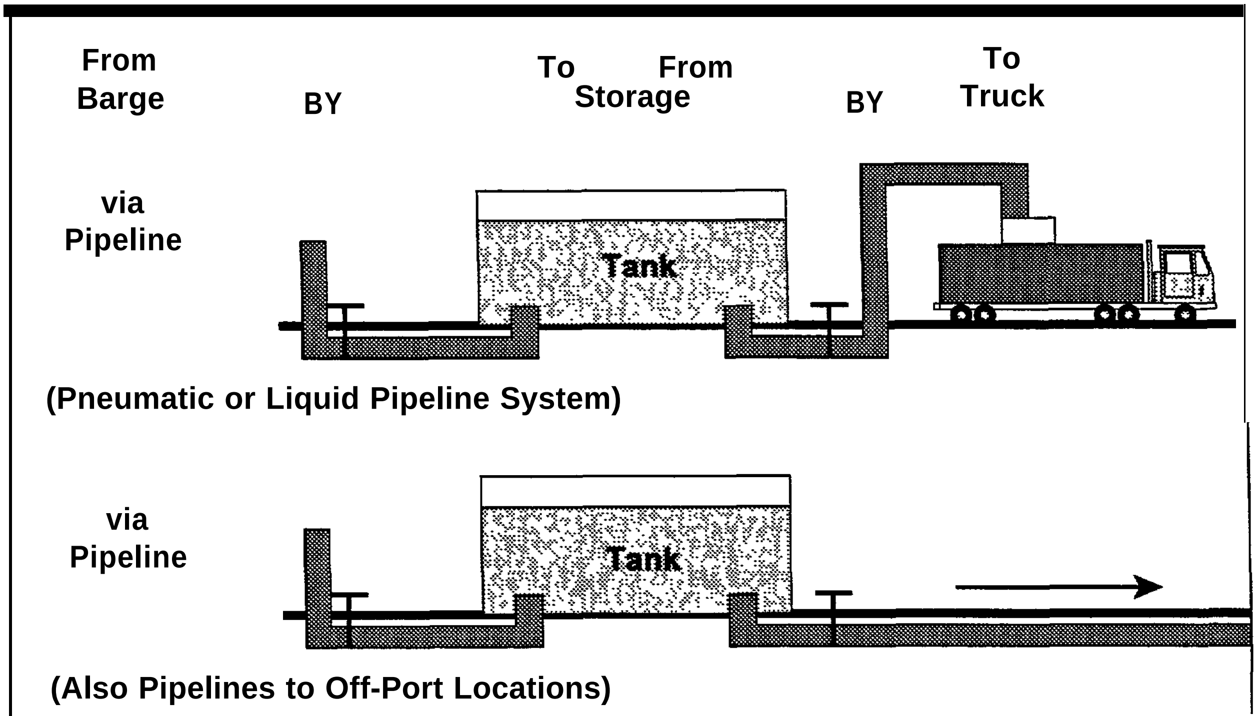
Source: ACOE

Intermodal Connectors: Barge/Trunk Example



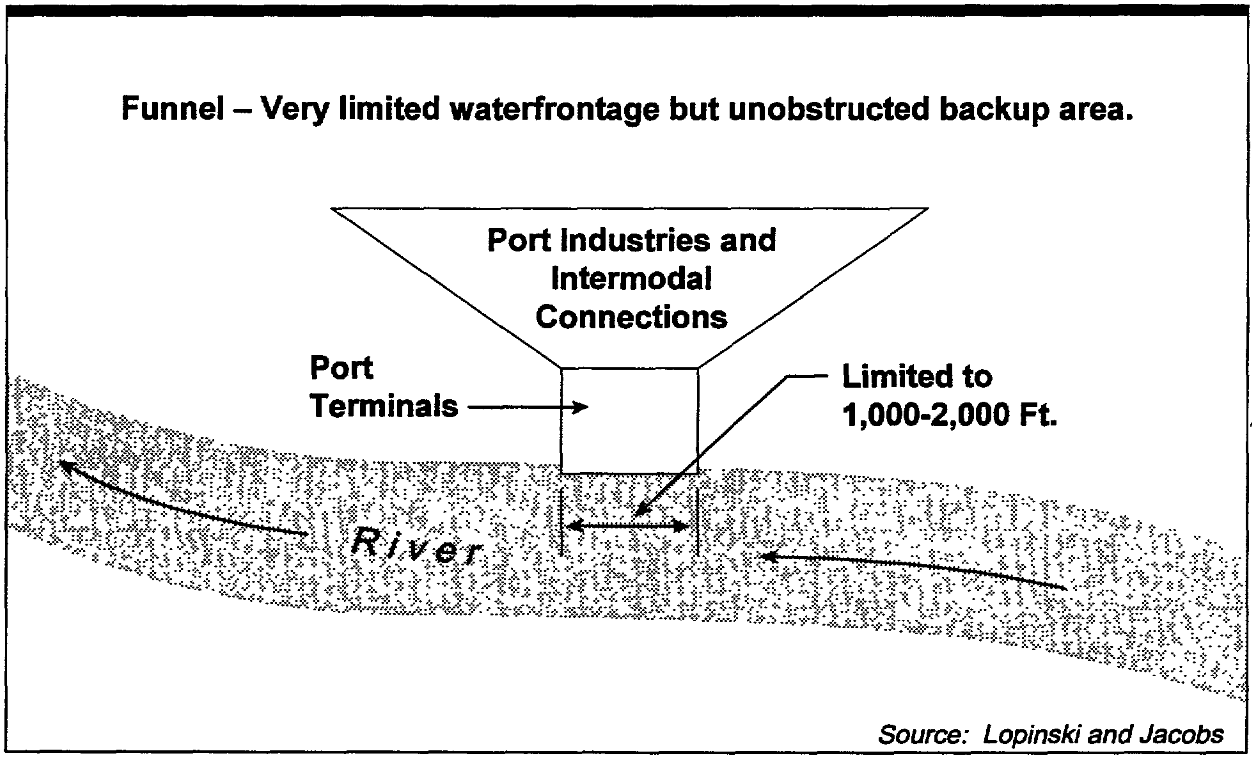
Source: Lopinski and Jacobs

Intermodal Connectors: Barge/Truck Example

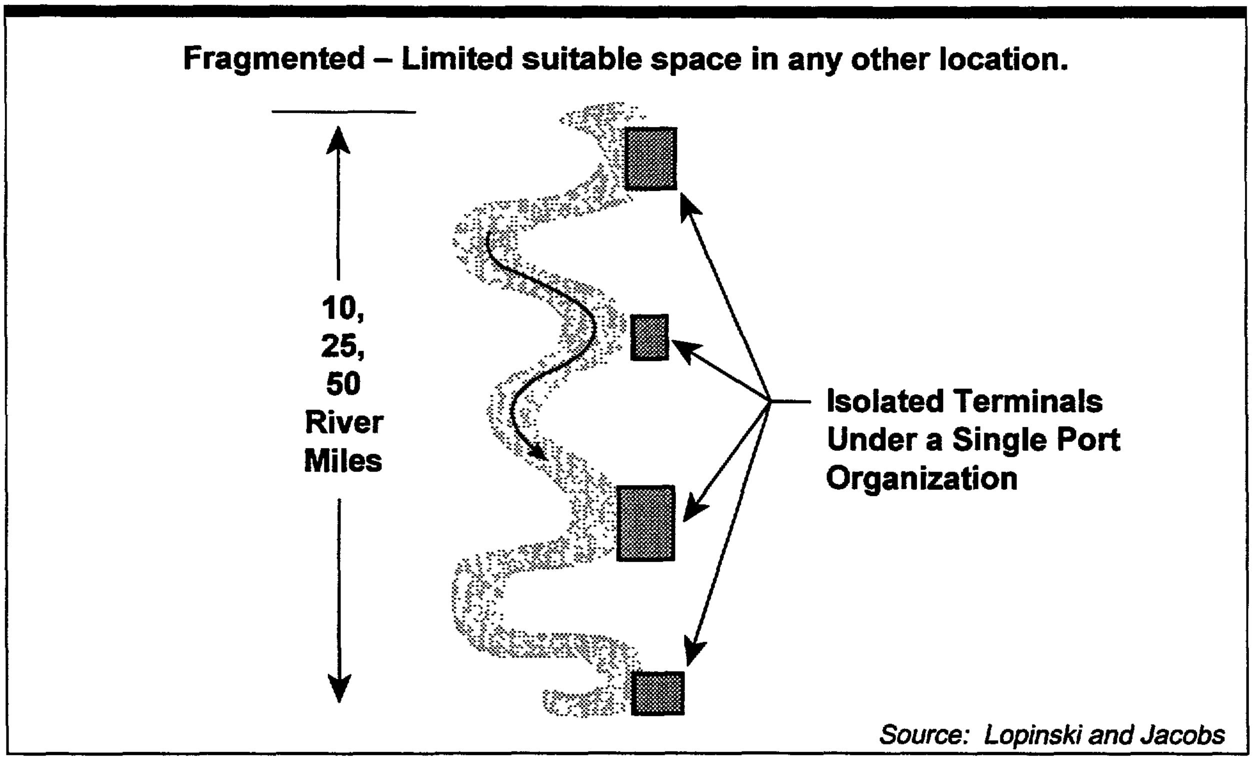


Source: Lopinski and Jacobs

Inland Waterways: Special Situations



Inland Waterways: Special Situations

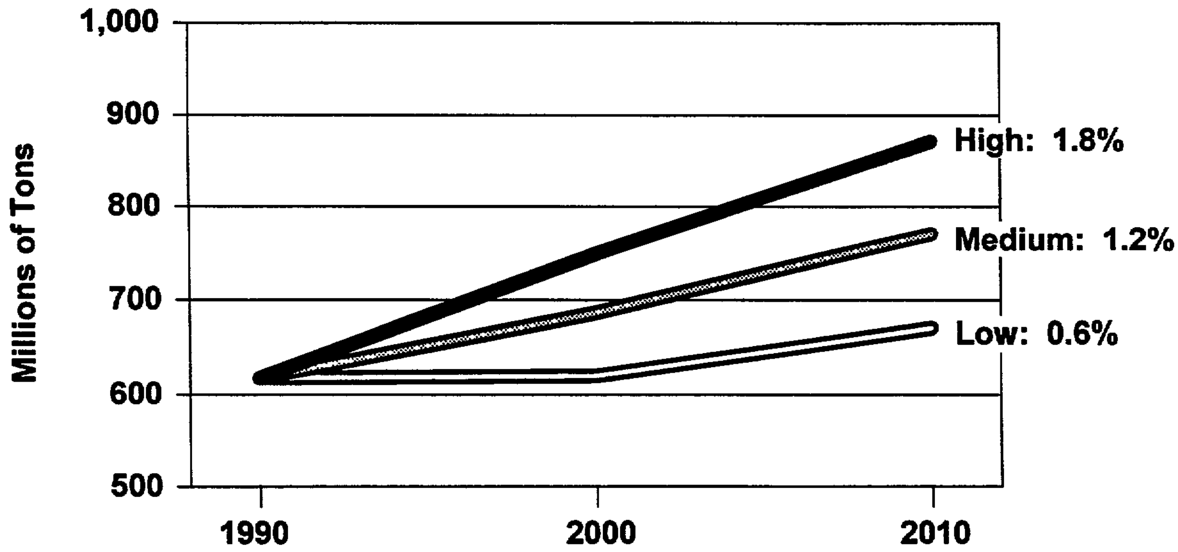


How Much Barges Hold

1 1500-Ton Barge	=	15 100-Ton Rail Cars	=	58 26-Ton Trucks
1 Tow (15 Barges)	=	225 Rail Cars	=	870 Trucks

Source: ACOE

Inland Waterway Tonnage Projections



Source: ACOE

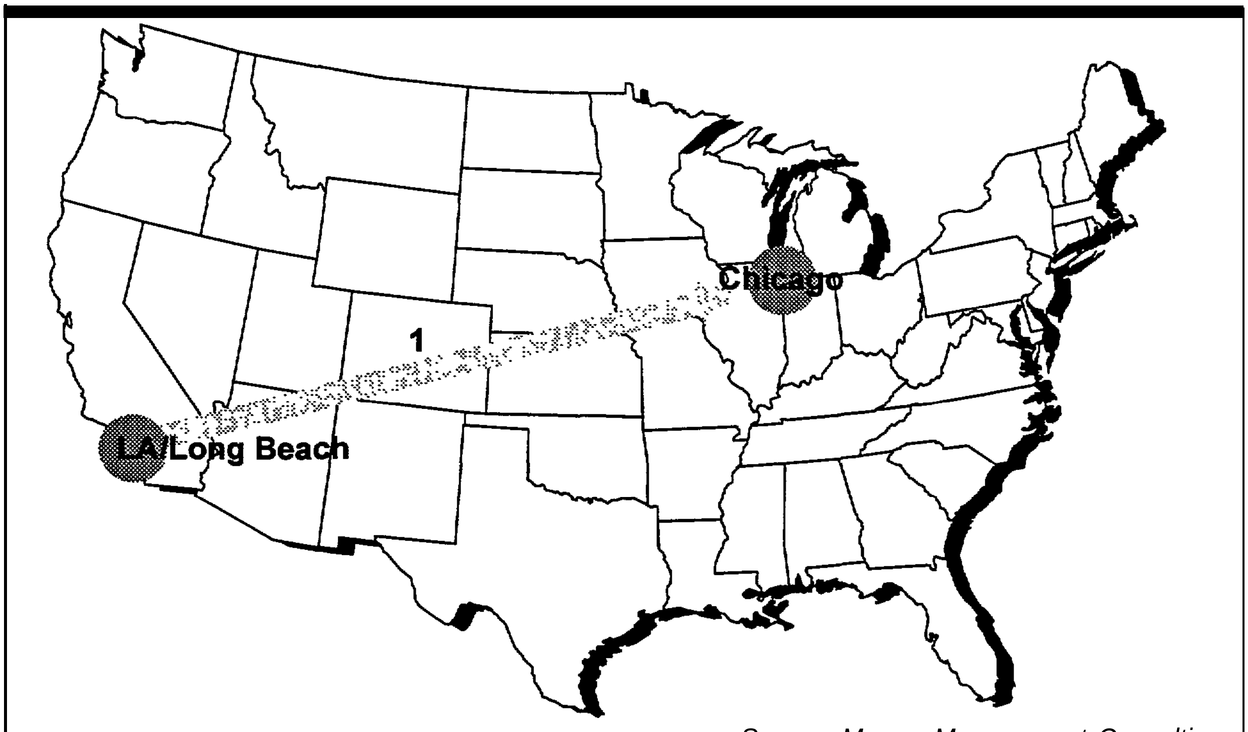
Age of Intermodalism and Domestic Containerization

Like containerization, intermodal rail has its roots in crude experimentation and has since been refined to a logistic science. At first, freight trains were loaded in a manner similar to break-bulk loading of a ship described earlier-loose cargo was loaded into undifferentiated freight cars by hand, or liquid or dry bulk commodities were poured into specialized cars. Later, to avoid having to unpack and re-pack truck trailers, containers were placed on flatcars (known as container-on-flatcar, or COFC); or entire trailers with chassis were placed on flatcars (known as trailer-on-flatcar, or TOFC).

With the growth of containerization came several technological advances that made rail movements cost-competitive with truck hauls over longer distances (typically 400 miles or more). The most significant was the double-stack train car-actually a section of a train with five separate “wells” for containers, onto which containers can be stacked two-high. Double-stack trains can be loaded and unloaded quickly by standard container-handling equipment, without rehandling the container contents. Other types of rail cars have been developed and refined for special applications, including the single-well container car and the “roadrailer,” a truck chassis that can be converted to run over rail tracks.

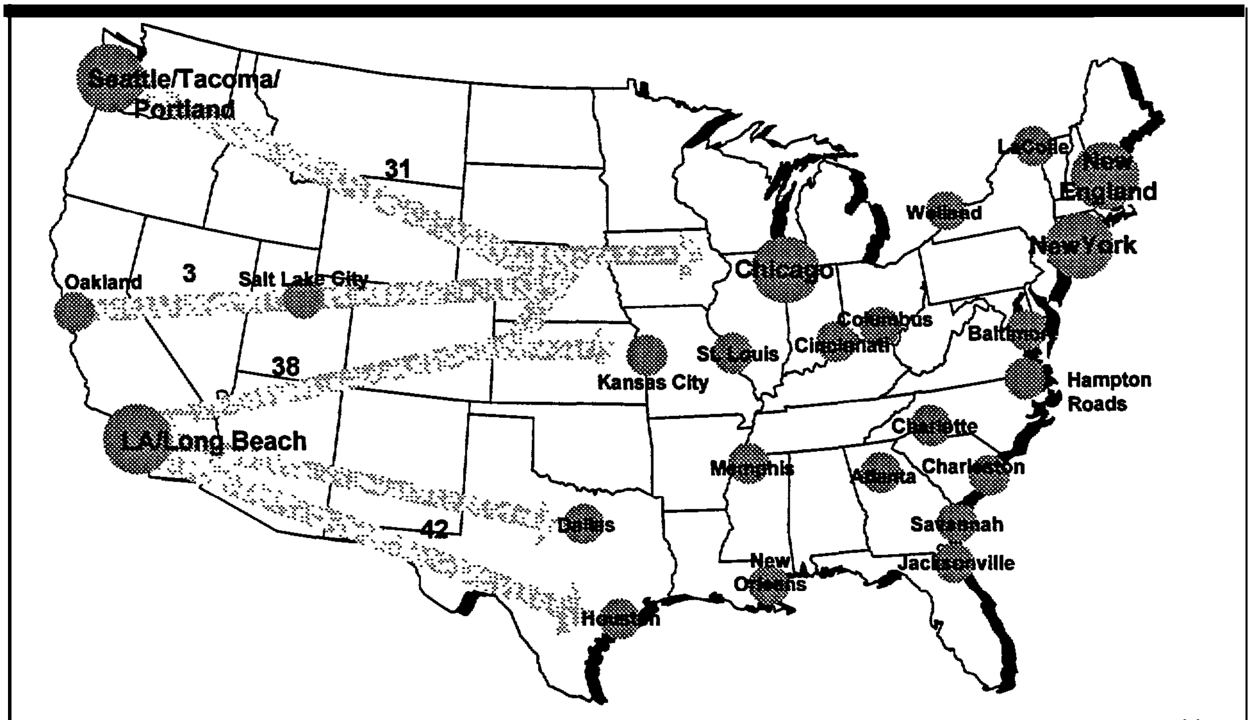
The increasing cost competitiveness brought on by these innovations has resulted in tremendous growth in intermodal rail movements-some ports move up to 40% of their “overland common point” cargo (that is, cargo bound for inland, non-local destinations) by rail. As rail companies offer better service at lower prices, shippers have increasingly used “landbridge” movements where rail substitutes for some part of the trip that would normally be water-borne. For example, cargo originating in Japan and bound for London might arrive at Los Angeles, move via train to New York and then be shipped across the Atlantic. Originally, this tended to be a one-way process, with loaded containers moving inland and empty containers moving back to port; but more recently domestic shippers have increasingly taken advantage of this unused “backhaul” capacity to move freight. A major topic in the domestic transportation industry is the degree to which domestic intermodalism is cost-effective, and a number of truck and rail carriers have formed exploratory partnerships. Finally, we must remember that trains have been, and will continue to be, an extremely efficient way to move non-containerized cargoes, especially low-value/high-weight dry bulk cargoes, to and from ports.

Weekly Eastbound Double-Stack Services April 1984 (1 Train Set)



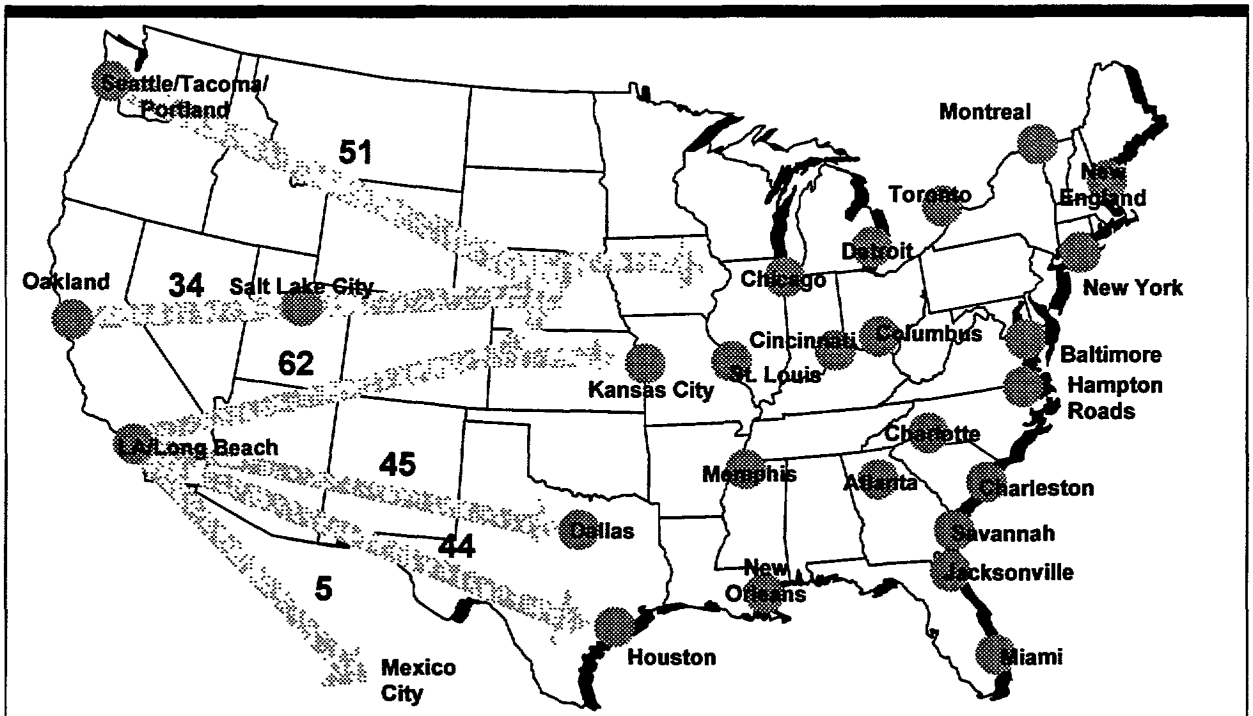
Source: Mercer Management Consulting

Weekly Eastbound Double-Stack Services April 1989 (114 Train Sets)



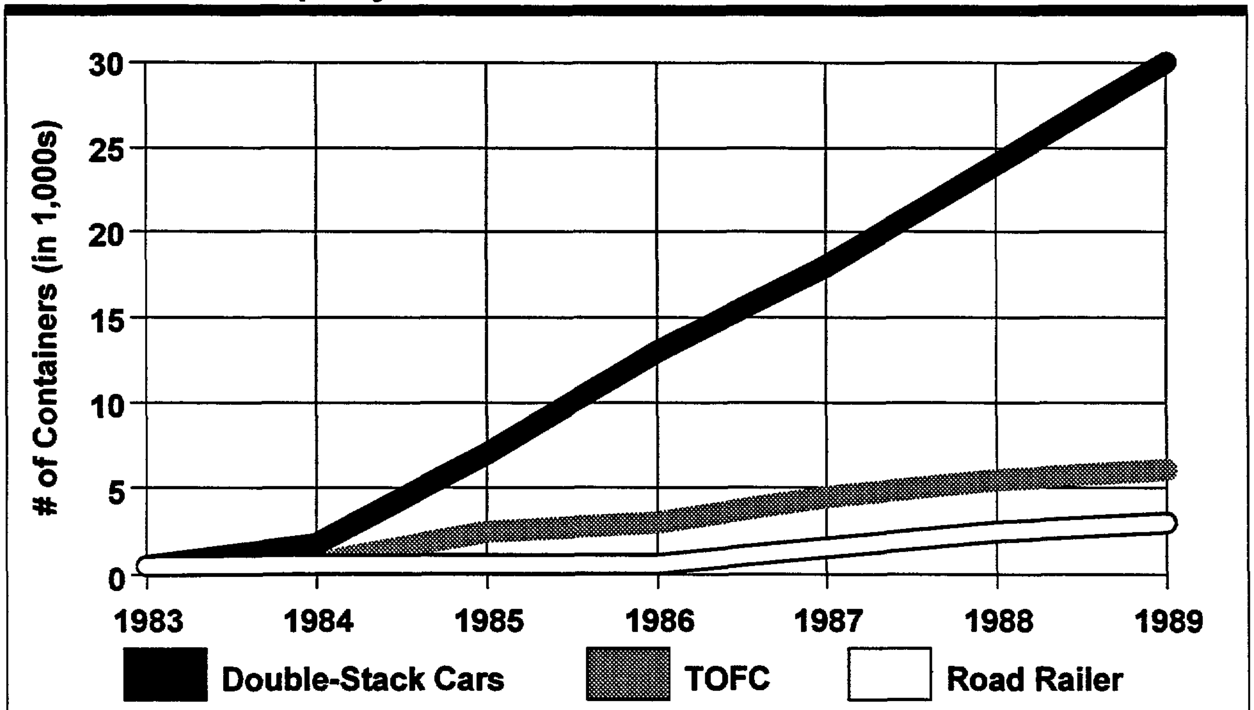
Source: Mercer *Management Consulting*

Weekly Eastbound Double-Stack Services December 1993 (241 Train Sets)



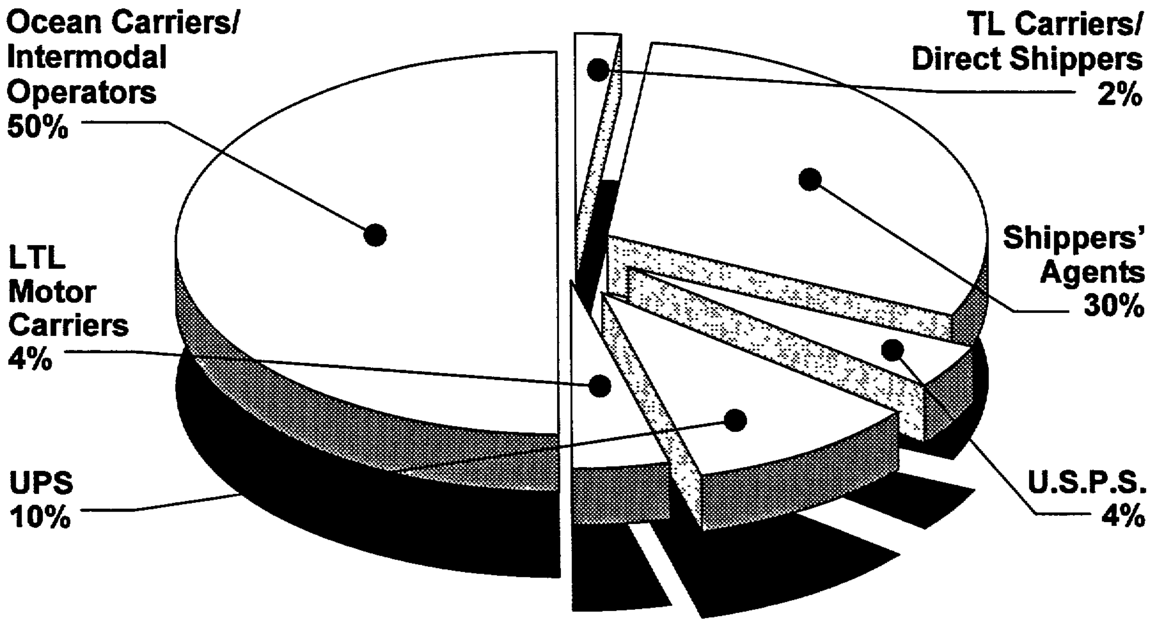
Source: Mercer Management Consulting

1989 Intermodal Capacity



Source: Vickerman · Zachary · Miller

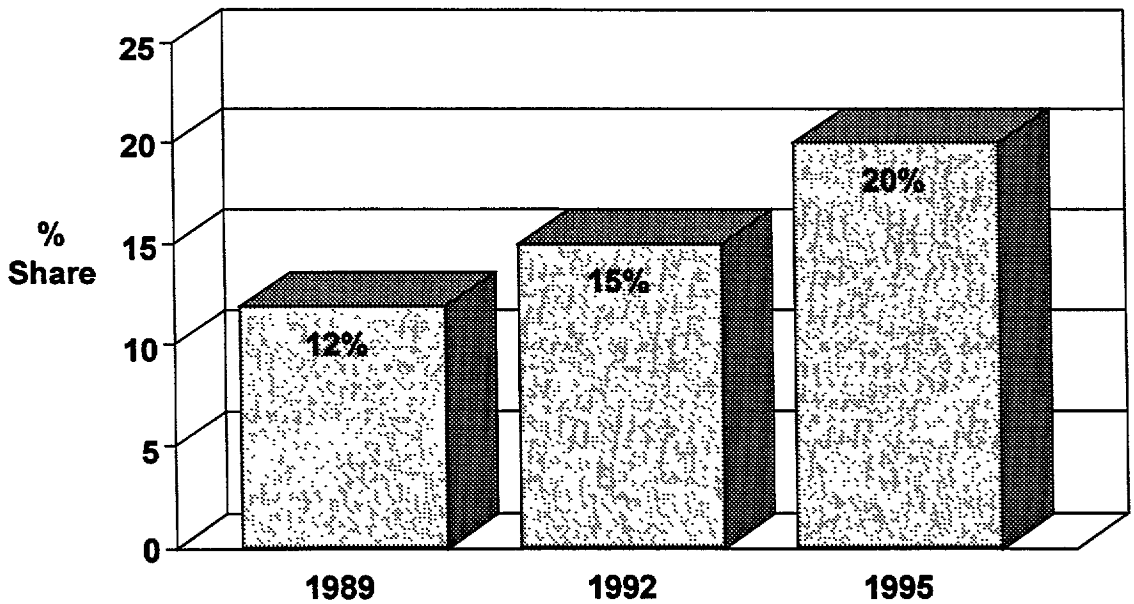
Intermodal Transportation Major Stakeholders



Source: Mercer Management Consulting, 1992

U.S. Intermodal Rail Market Share is Growing

Intermodal Market Share of Trailer Load Shipments Moving 500 Miles or More



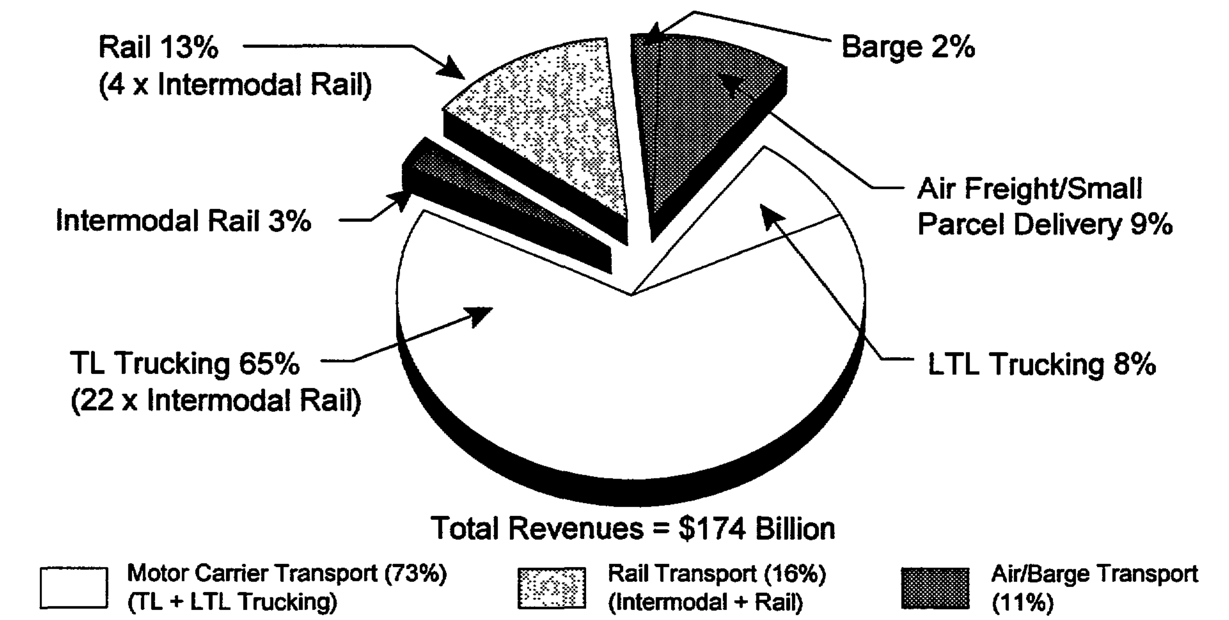
Source: 1992 IANA Intermodal Index

U.S. Intermodal Rail Market Share is Growing

- *More than one-half of the nation's shippers with revenues exceeding $2 billion shifted traffic from truck to intermodal rail in 1992.*
- *One-third of all shippers turned from truck to intermodal rail in 1992.*

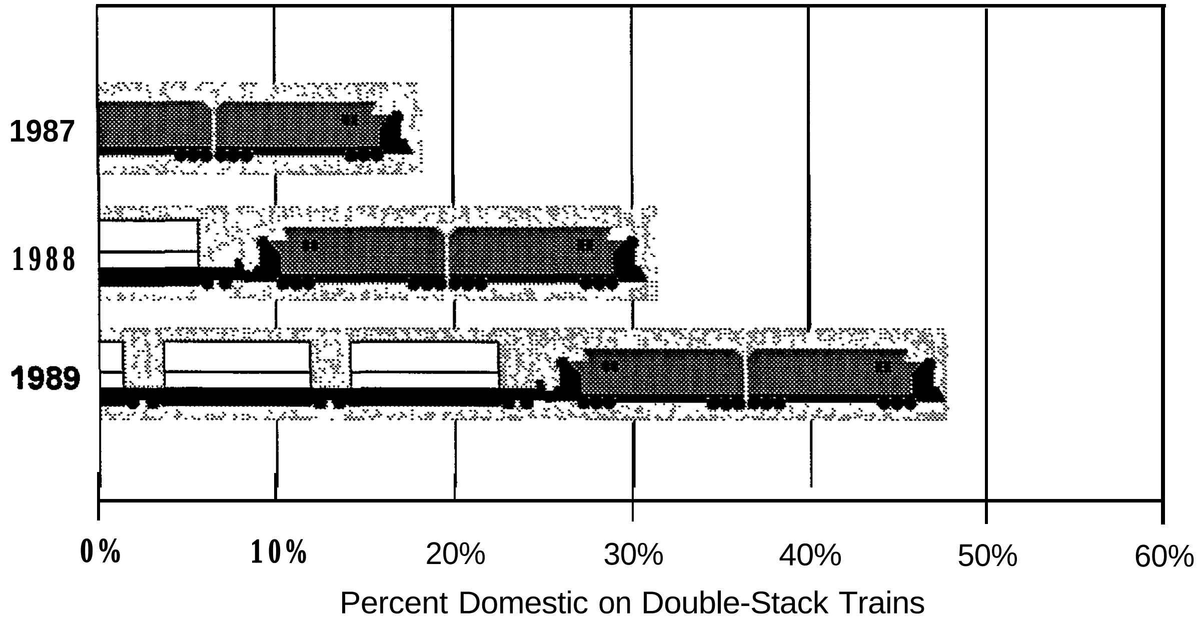
Source: 1992 IANA Intermodal Index

U.S. Intercity Freight Revenues



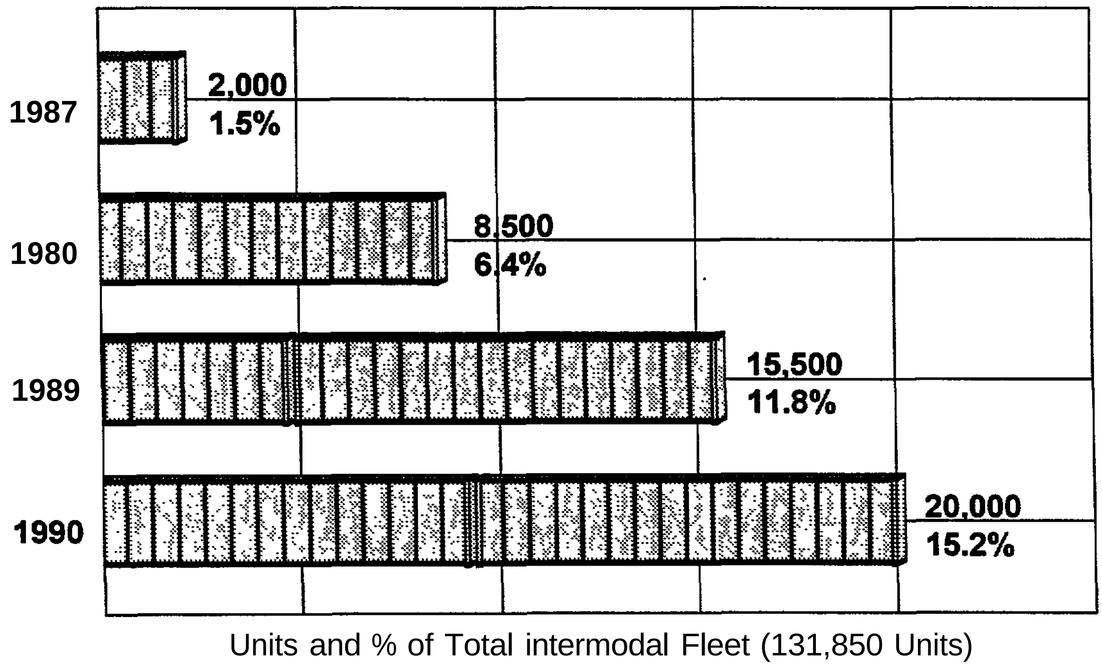
Source: TPA, 1987

Percent of Domestic Cargo on Double-Stack Trains at the Ports of Los Angeles and Long Beach ICTF



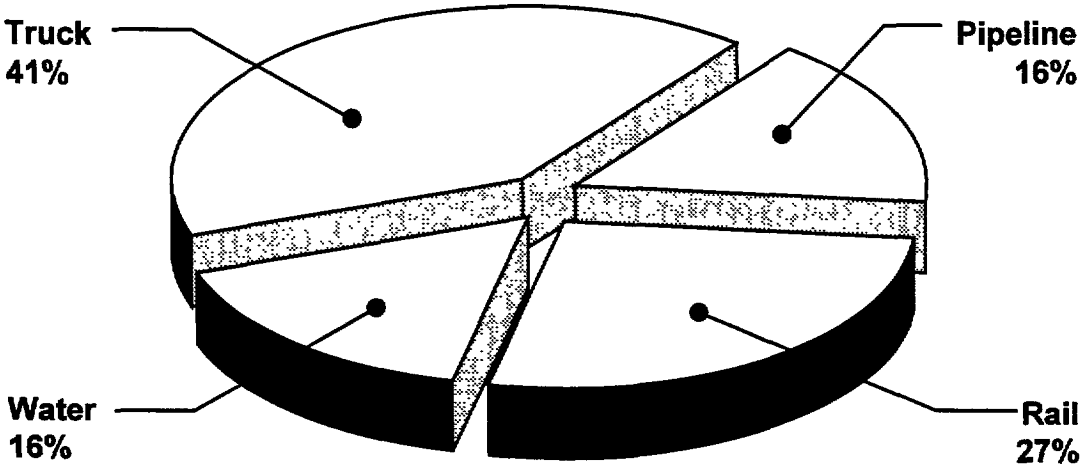
Source: Traffic world, October 1989

U.S. Domestic Container Fleet Size



Source: Transamerica Leasing, May 1990

U.S. Intercity Freight Transport (1990)



Total Tonnage = 6.4 Billion Tons

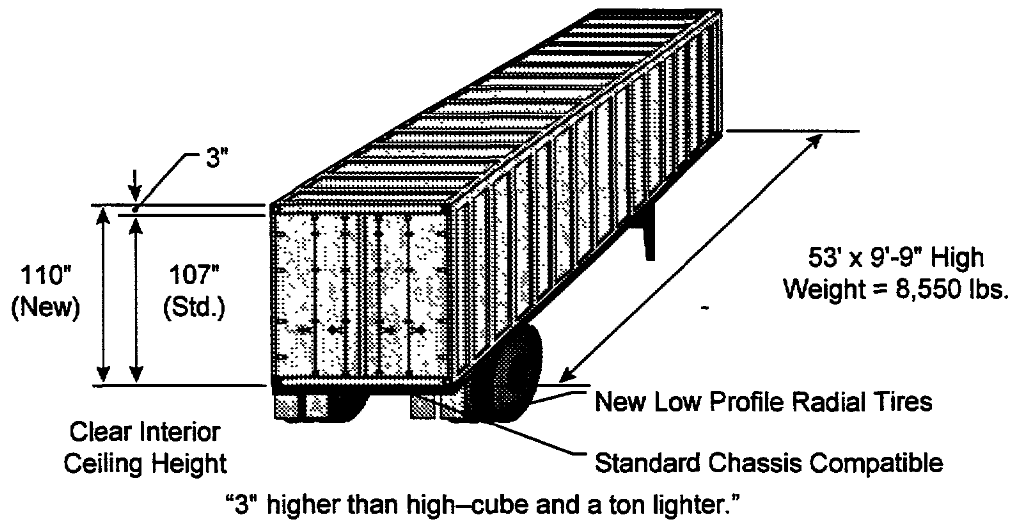
Source: ENO Transportation Foundation 1991

Air Cargo

Air Cargo Market Segments

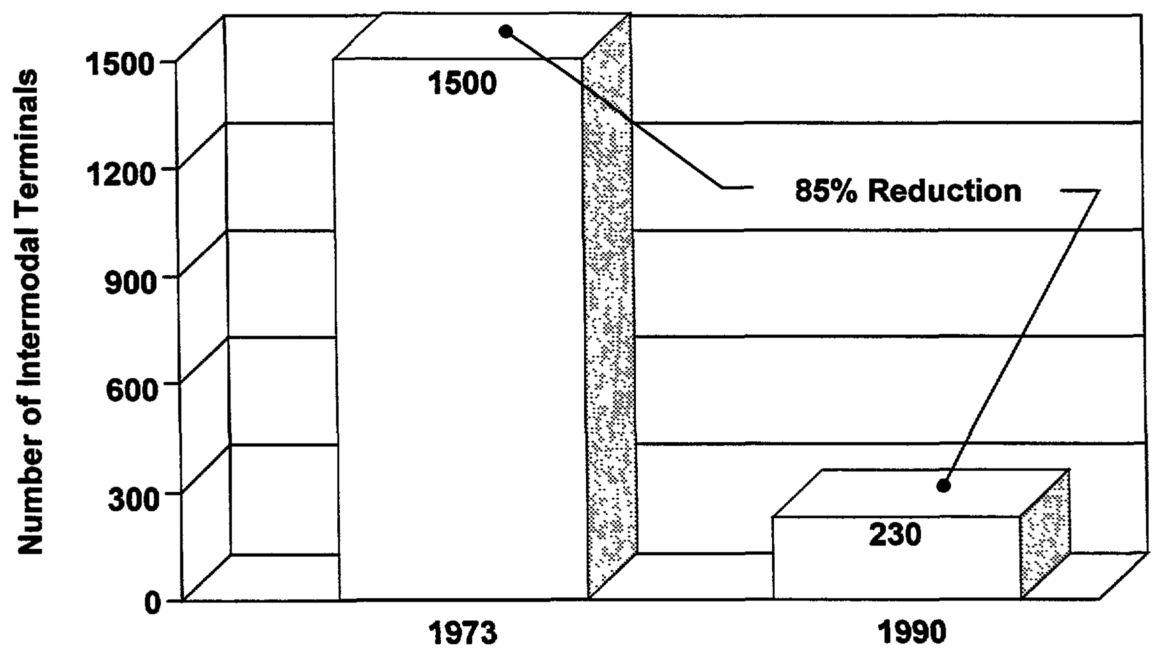
- *High-value, low weight and/or time sensitive commodities.*
- *Express packages, documents and mail.*
- *May be shipped in dedicated all-cargo planes or as "belly cargo" on commercial flights.*
- *One new Boeing 777 can handle about 250 tons in all-cargo configuration; equivalent of ten 25-ton trucks or 2 1/2 100-ton rail cars.*

APL/Transamerica New Super High–Cube Domestic International Container (30 Prototype Units by February 1993)

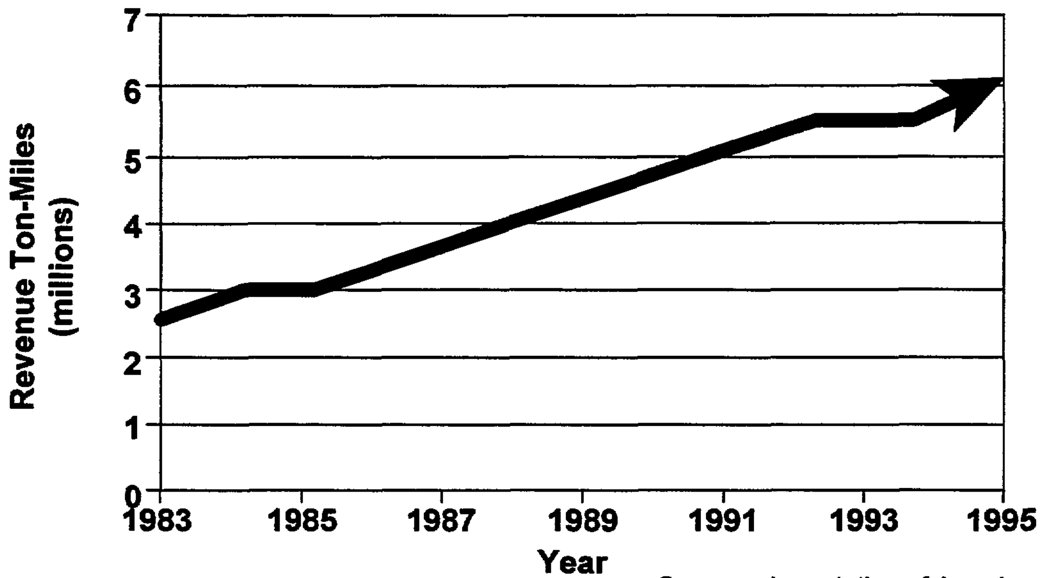


Source: Journal of Commerce, January 1993

U.S. Railroads Have Consolidated the Number of Intermodal Terminals



U.S. Intermodal Rail Productivity Advances
Revenue Ton-Miles (Millions) Per Railroad Employee



Source: Association of American Railroads

U.S. Intermodal Rail Service Fuel Efficiency

In 1991, the Federal Railroad Administration (FRA) estimated that intermodal rail service was 1.4 to 3.4 times more fuel efficient than trucks.

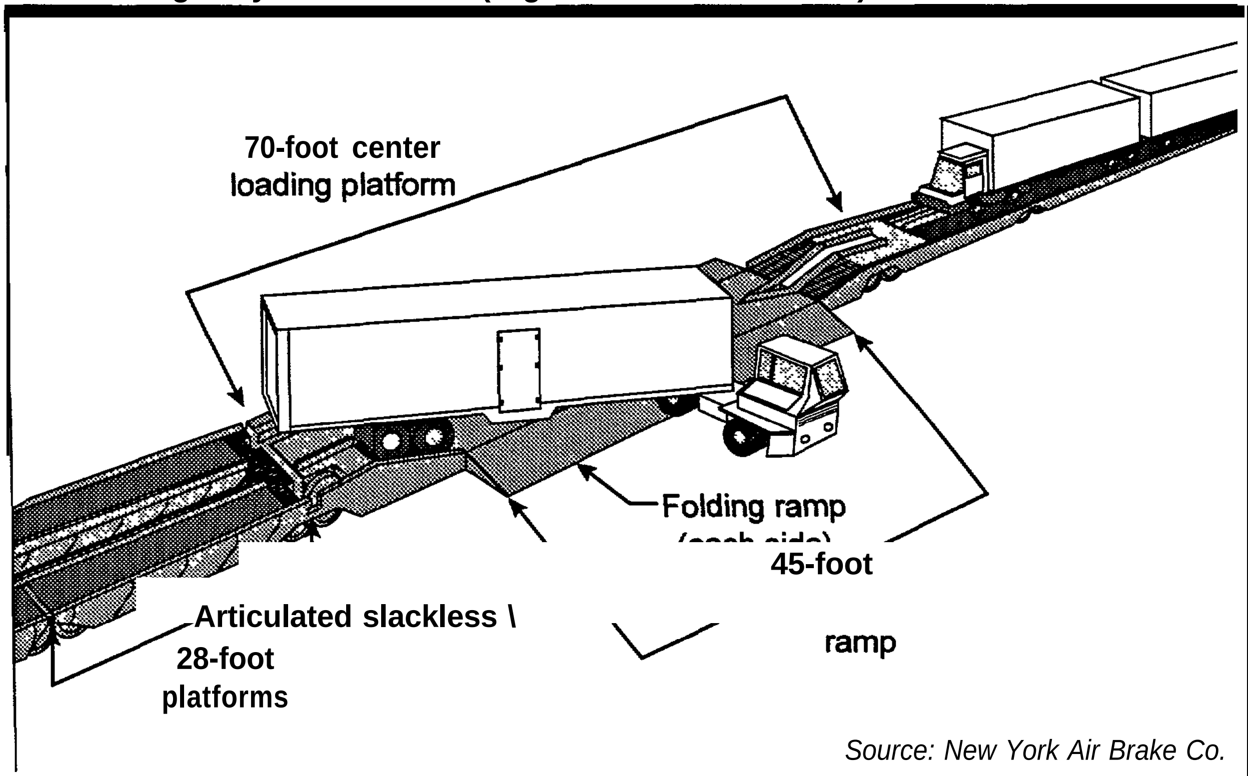
Source: Federal Railroad Administration 1991

Triple Crown Service Update -The N/S & Conrail $50 Million Joint Venture

- *In early 1994, the railroads placed the largest order yet for Roadrailer equipment.*
- *This order included:*
  - *1770 Roadrailer Mark V 53 ft. plate trailers.*
  - *885 Rail Bogies.*
  - *13 Couple Mate Bogies.*
- *Triple Crown's fleet will now be in excess of 3750 units.*
- *When old Mark IV units are retired, train length will climb from 75 to 125 units (pending FRA approval).*

Source: IANA, intermodal Insights, February 1994

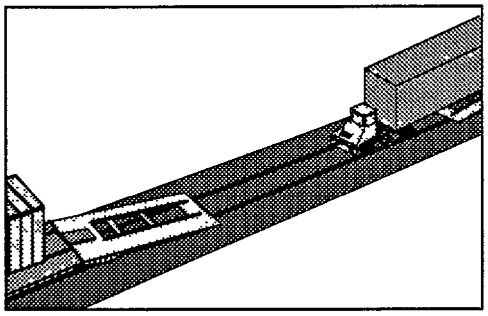
The Iron Highway - Rail-RO/RO (High Performance TOFC)



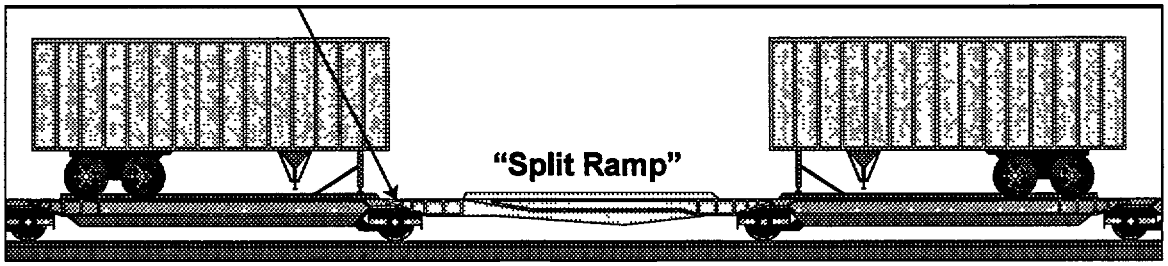
Source: New York Air Brake Co.

CSXI "Iron Highway"" ("Split Ramp" Design for Short-Haul Delivery)

Up to five 1,200-foot iron highway elements can be linked to create a 6,000-foot train (maximum of 100 53 -foot trailers).



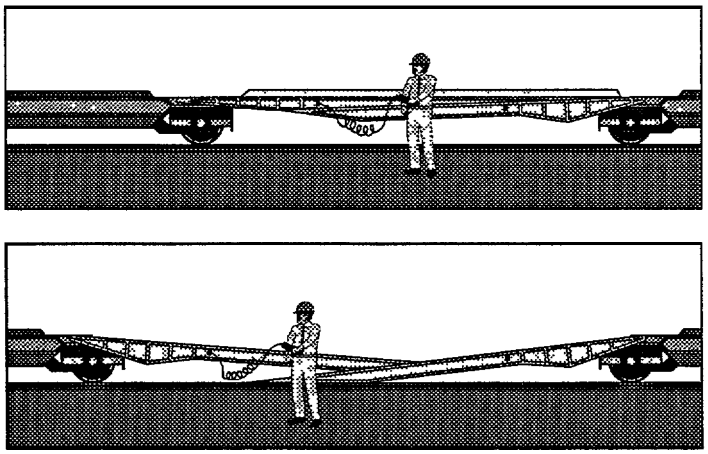
New elastomeric springs with steerable independent rotating wheels.

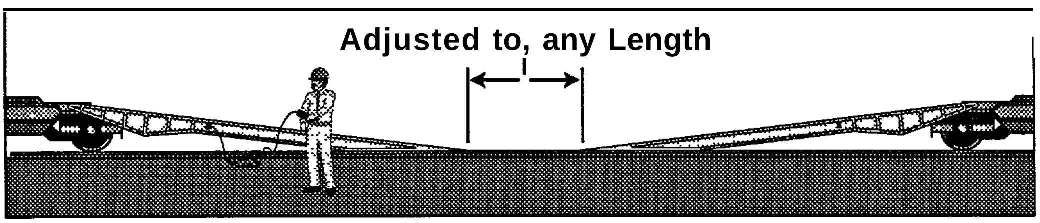


Source: CSX In tetmodal, September 7994

CSXI "Iron Highway"" ("Split Ramp" Design for Short-Haul Delivery)

Operator opens split ramp using hand-held control box. Brakes on one-half of unit automatically lock while other half advances slowly.





Source: CSX Intermodal September 1994

The CSX Intermodal Iron Highway Status Report

June 94: *CSXI purchased patent rights from New York Air Brake Company*

July 94: *CSXI solicits bids for "systems integrator/manufacturer" (9 firms).*

August 94: *CSXI selects systems integrator.*

Early 95: *Market testing of rail and terminal operations.*

Target Market: Alternative short-haul (300 – 500 mile) domestic transportation technology

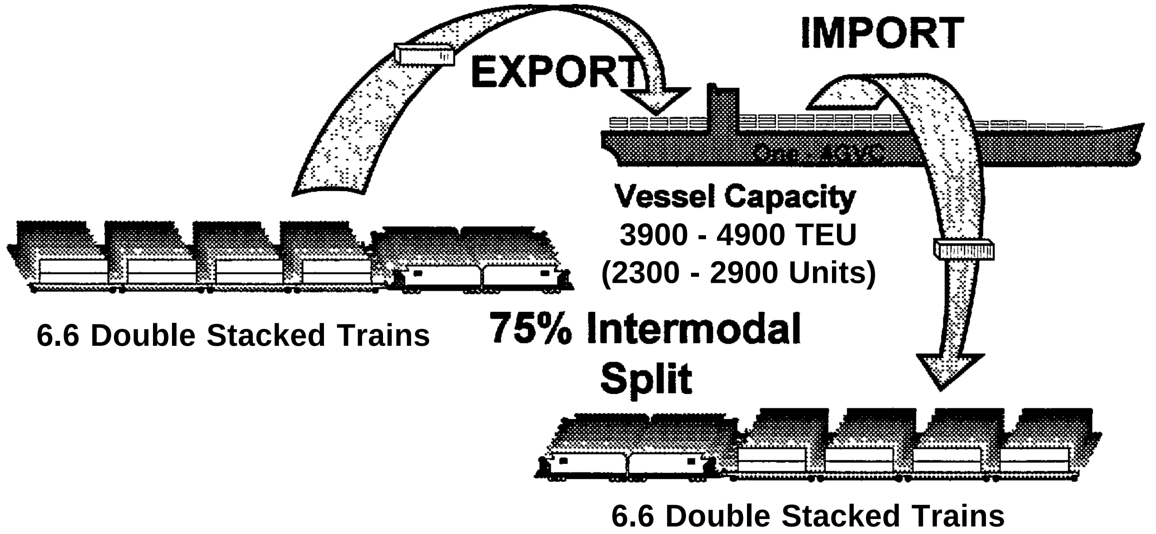
Source: Intermodal Reporter, July 1994

The Intermodal Rail Interface

The continued growth of intermodal rail has led to the need for specialized Intermodal Container Transfer Facilities, or ICTFs, where containers are transferred from truck chassis or ground storage to rail cars. In Los Angeles, these transfers initially took place at existing railyards some distance from the ports of Los Angeles and Long Beach and required long truck trips, leading to high drayage costs and increased congestion. Because truck trips and vehicle miles traveled decrease in proportion to the proximity of the ICTF, ports are favoring the development of ICTFs close to ("near- dock") or actually within ("on-dock") container terminals. For example, Los Angeles and Long Beach have developed a near-dock ICTF approximately 5 miles inland. This has been followed by on-dock facilities for three different container terminals.

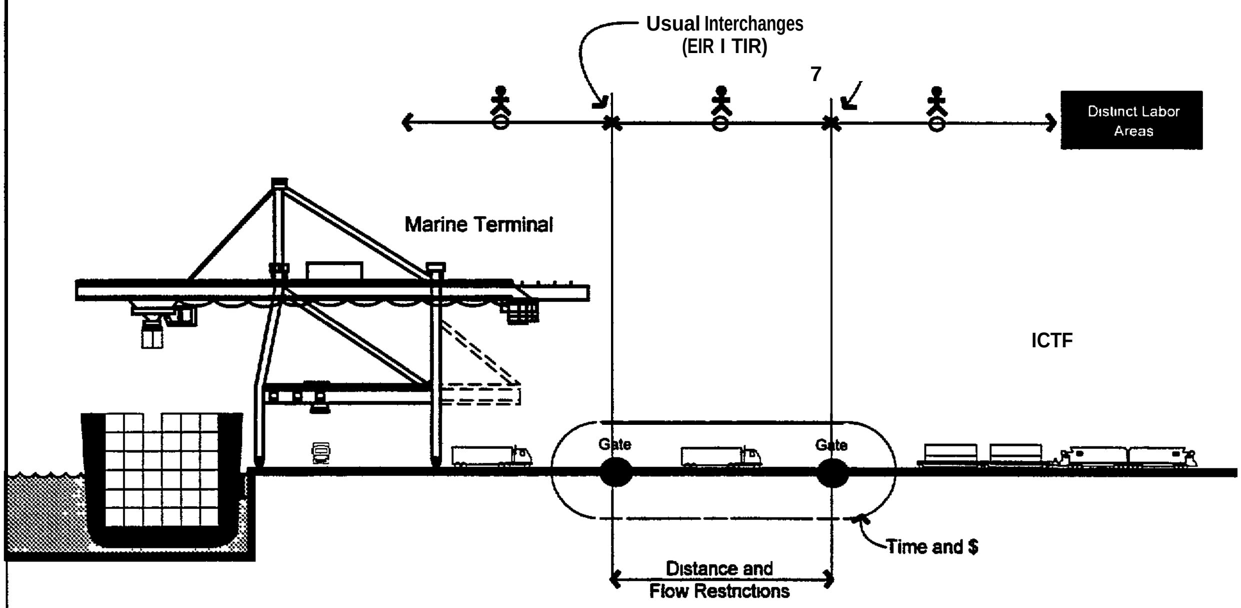
In response to environmental impacts associated with increased train traffic (noise, vibration, vehicle delay, etc.), ports are planning major capital improvements as mitigation. Los Angeles and Long Beach are sponsoring the Alameda Consolidated Transportation Corridor, in which three rail lines between the ports and remote ICTFs will be consolidated onto a single, grade-separated route. Other ports are concerned with increasing tunnel and bridge clearances to accommodate double-stack trains. These projects have required stronger partnerships between ports and rail companies.

Post Panamax Vessels Produce High Intermodal Rail Volumes (Weekly Vessel Call)



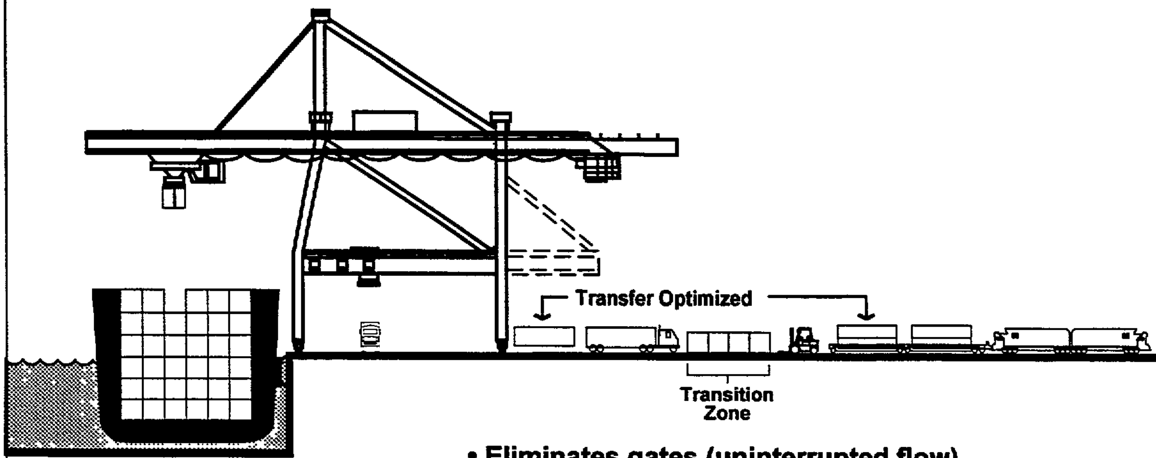
Source: Vickerman · Zachary · *Miller / Mercer Management*

Intermodal Interface The Way it Is



Source: Vickerman · Zachary · Miller

Intermodal Interface The Way it Could Be

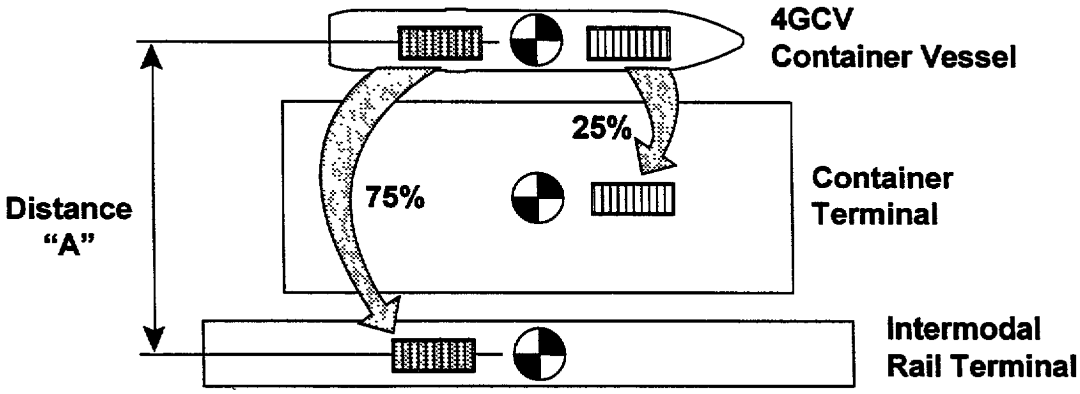


- **Eliminates gates (uninterrupted flow).**
- **Reduces distance and traffic / environmental impact.**
- **Minimizes hostler movement.**
- **Minimizes rail car movement.**
- **Maximizes loading / unloading capability.**
- **(Lift Productivity)**
- **Unrestricted non-rail container flow.**

Source: Vickerman · Zachary · Miller

"On-Dock" Intermodal Rail Efficiencies

(Assume: Intermodal Split = 75% and Weekly Vessel Call.)



ICTF Proximity	Distance "A"	Dray Per Vessel Call	Annual Dray Per Berth*	Percent Change
On-Dock	2000 Ft.	1,477 Mi.	153,636 Mi.	—
Near-Dock	5000 Ft.	3,693 Mi.	834,091 Mi.	150%
Remote	3 Mi.	11,700 Mi.	1,216,800 Mi.	692%

***Assume two vessel calls per week.**

Source: Vickerman · Zachary · Miller

Today's Double – Stack Intermodal Moves

- *70 to 80 Acres/Marine Terminals*
- *Gate Congestion*
- *Dwell in Container Yard*
- *Consolidated Moves*
- *Lack of Inventory Control*

Source: *Vickerman · Zachary · Miller*

Tomorrow's Double – Stack Intermodal Moves

- *On-Dock or Near Dock Rail*
- *3 to 5 Acre ITZ*
- *Less than One Hour Dwell*
- *Continuous Moves*
- *No Gate*
- *Elimination of Truck Dray*

Source: Vickerman · Zachary . Miller

Small Business Innovation Research Program

Goal:

To demonstrate the concept of simultaneous load and discharge of a vessel.

Why Simulation:

Simulation can quantify the reduction in container storage space necessary, as well as critical resource utilizations (cranes, straddle carrier). The accompanying animation can illustrate the vessel discharge and load procedure.

Source: Vickerman · Zachary · Miller

Truck Facilities

Warehousing facilities for storage, transshipment and distribution are key elements of truck/seaport, truck/rail and truck/truck intermodal connections. Typically, they consist of storage sheds-ranging from small to enormous-along with loading docks, specialized freight handling and/or climate control equipment.

They perform two vital functions in the freight logistics chain. First, in many cases, the contents of a container are shipped “LTV’-less-than-container load, which means that only part of the contents of a given container are bound for a certain destination. That means that the freight handler must unload the container, separate its contents and then re-pack the contents for ultimate delivery. This can be done at the seaport itself, at a railyard or at an off-site transshipment facility The second function is interim storage of intermodal freight. Freight movements must be carefully scheduled and coordinated. If a full container arrives at a port, it can sit in the yard untouched until someone picks it up. The same is true with automobiles. However, with LTL containers, neo bulk or break-bulk cargoes (like rolled steel or perishables shipped on pallets), storage between modal movements may be necessary. Distribution centers for major companies (e.g., Sears) also should be considered part of this category, even though some of the transfers are truck-to-truck and completely domestic.

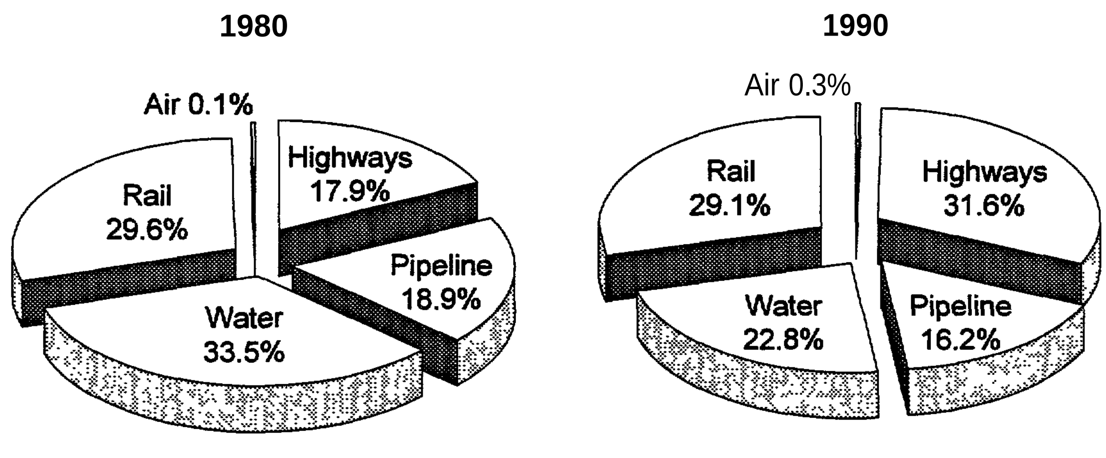
Transshipment and storage facilities come in a variety of sizes and are found in a variety of locations. Container terminals may have their own on-site facilities, or a seaport may operate a consolidated facility off-site (the Port of Los Angeles does both). Airports may have storage and transshipment facilities as part of “cargo cities.” Large and small trucking firms, rail operators, large retailers and manufacturers and others maintain these facilities, and there may be hundreds of them in a major metropolitan area.

Their diversity and sheer number makes storage and transshipment facilities a difficult subject to study. We are not aware of any comprehensive treatment in the literature. Recently, the Port of Long Beach conducted studies in an attempt to identify the location and extent of transshipment activity as part of its TRUCKSIM traffic model; but these efforts were unsuccessful.

In a given area, it is generally easy to identify major storage and transshipment facilities, with smaller ones tending to blend into the overall transportation network. Since the major facilities are also the largest trip generators, our course will selectively focus on them and will consider smaller facilities on a par with other “system-wide” intermodal interfaces.

There appear to be conflicting trends at work in the transshipment and storage industry. On the one hand, increases in containerization and intermodal rail mean more LTL boxes and more mode changes, resulting in a greater need for transshipment and storage facilities. On the other hand, the availability of electronic tracking systems for cargo and an increasing emphasis on logistical coordination and “just in time” delivery tend to reduce the amount and duration of transshipment and warehousing activity. These issues will require further research.

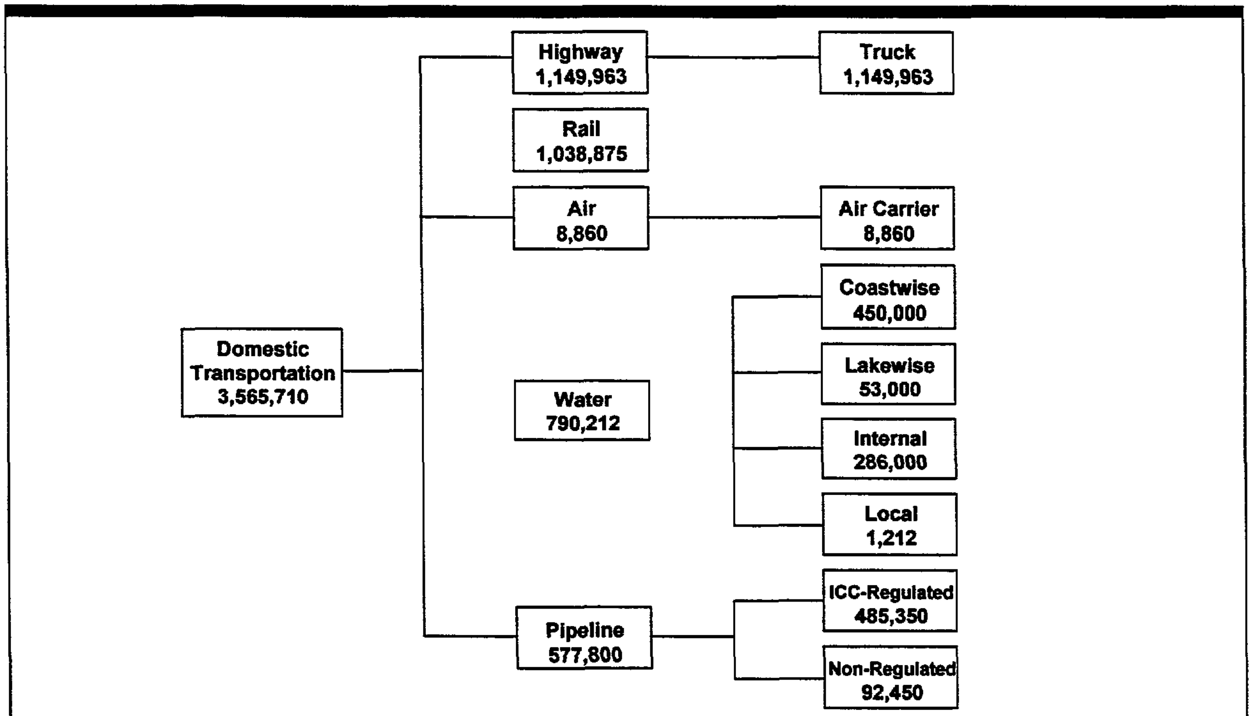
Freight Transportation by Mode



In 1990, the Nation’s highway system carried 31.6 percent of the total revenue ton-miles of freight compared to 17.9 percent in 1980.

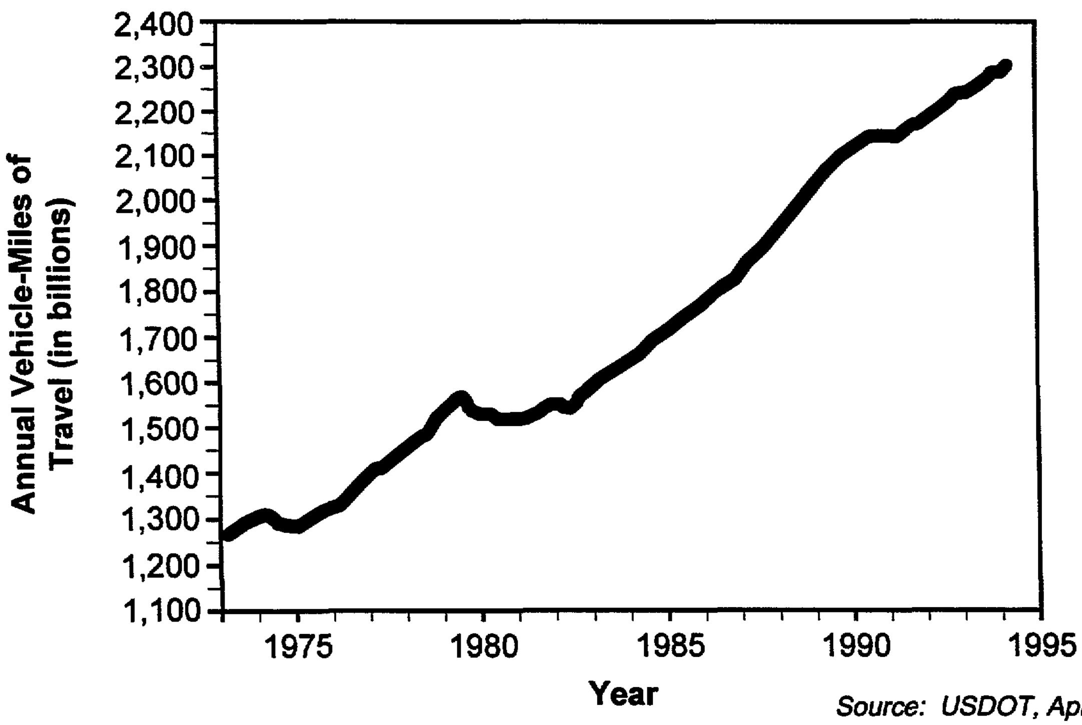
Source: USDOT, Annual Report, June 1992

Revenue Ton-Miles of Freight (millions) – 1992



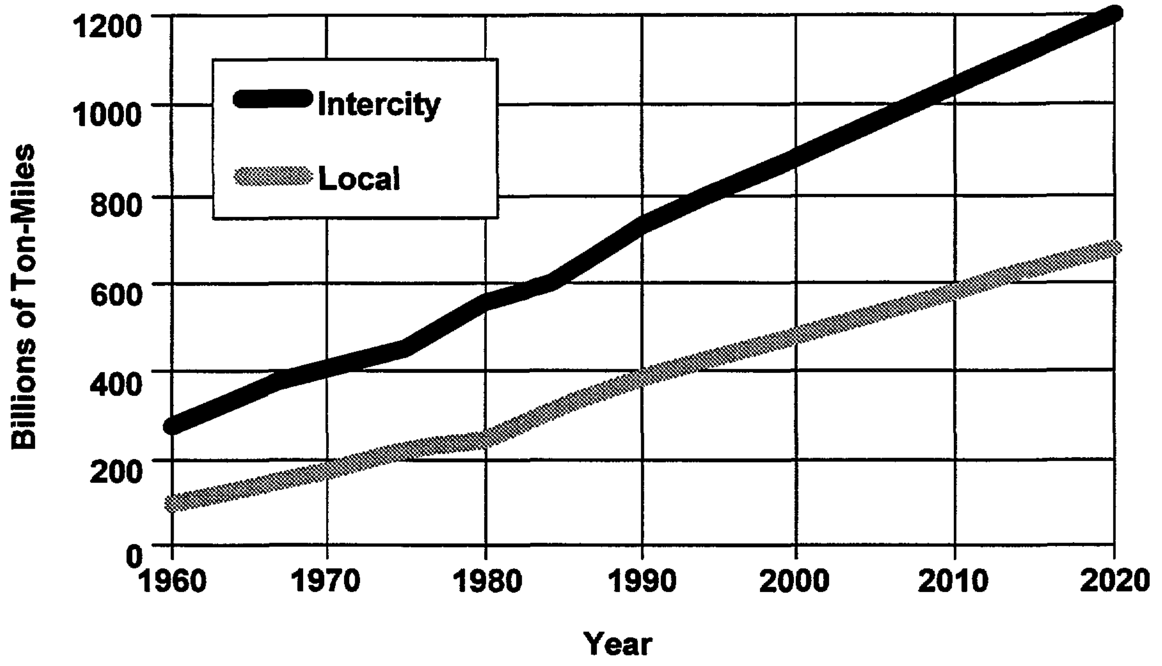
Source: USDOT Bureau of Transportation Statistics, 1993

Traffic Volume Trends: Moving 12-Month Total on All Highways



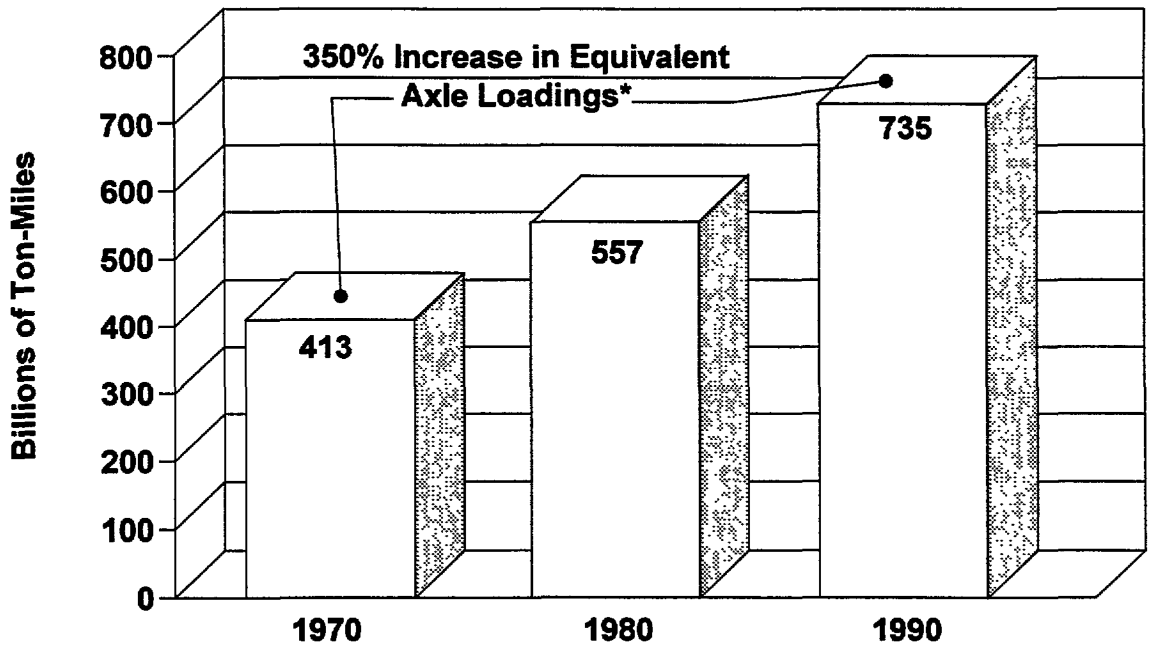
Source: USDOT, April 1994

U.S. Truck Freight Growth 1960 – 2020



Source: U.S. DOT Report on Tube Transportation February 1994

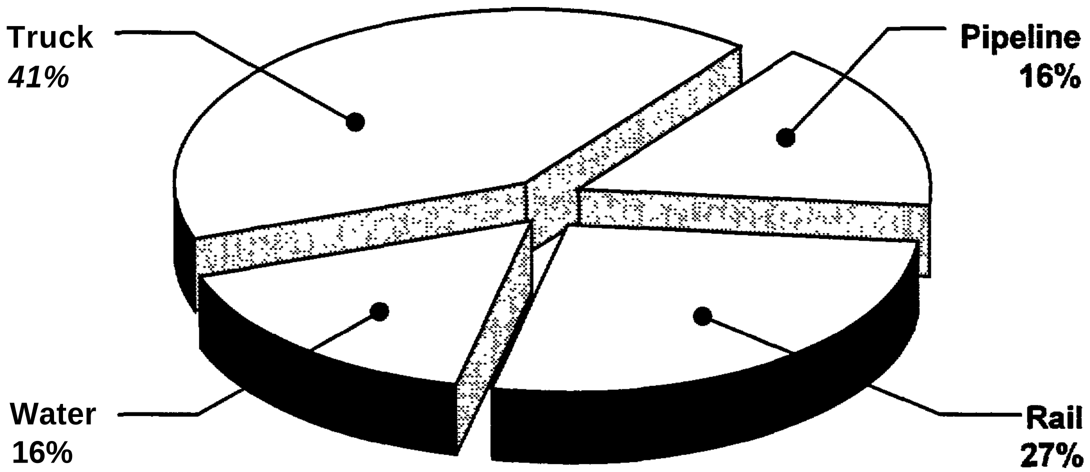
U.S. Intercity Truck Freight Growth in Ton-Miles



***(One Axle Loading = 18,000 Lbs. Pass)**

Source: ENO Transportation Foundation 1991

U.S. Intercity Freight Transport (1990)



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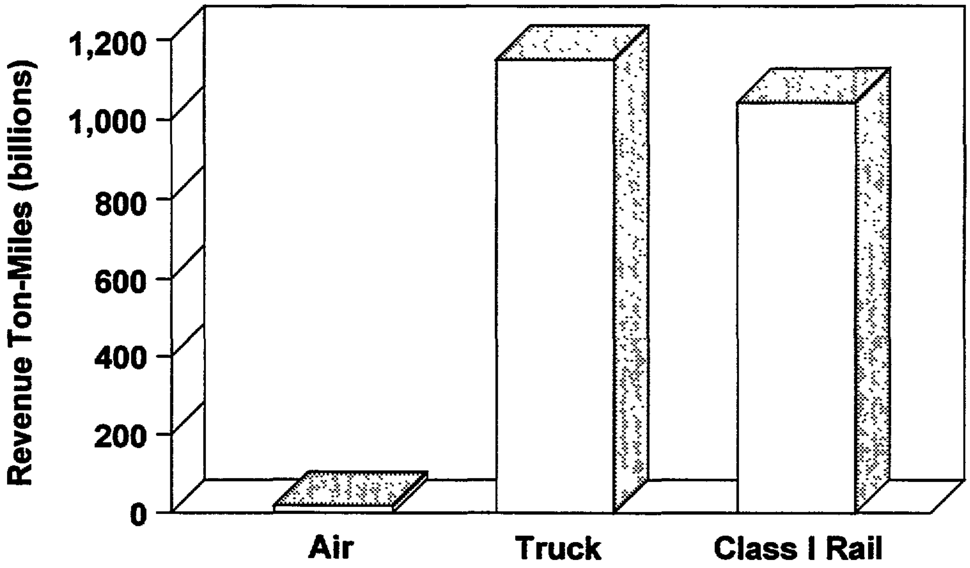
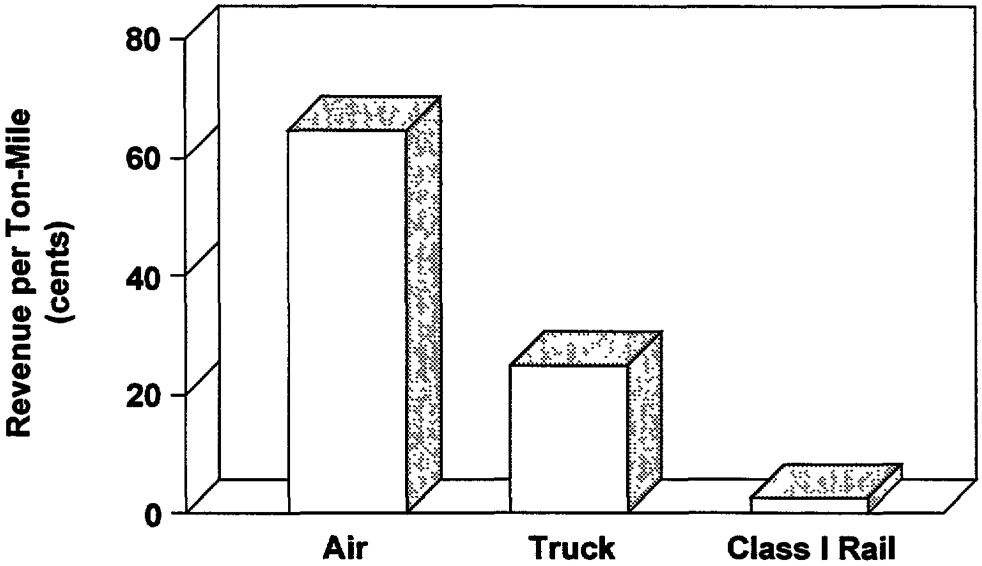
Revenue Ton-Miles by Mode (1991)



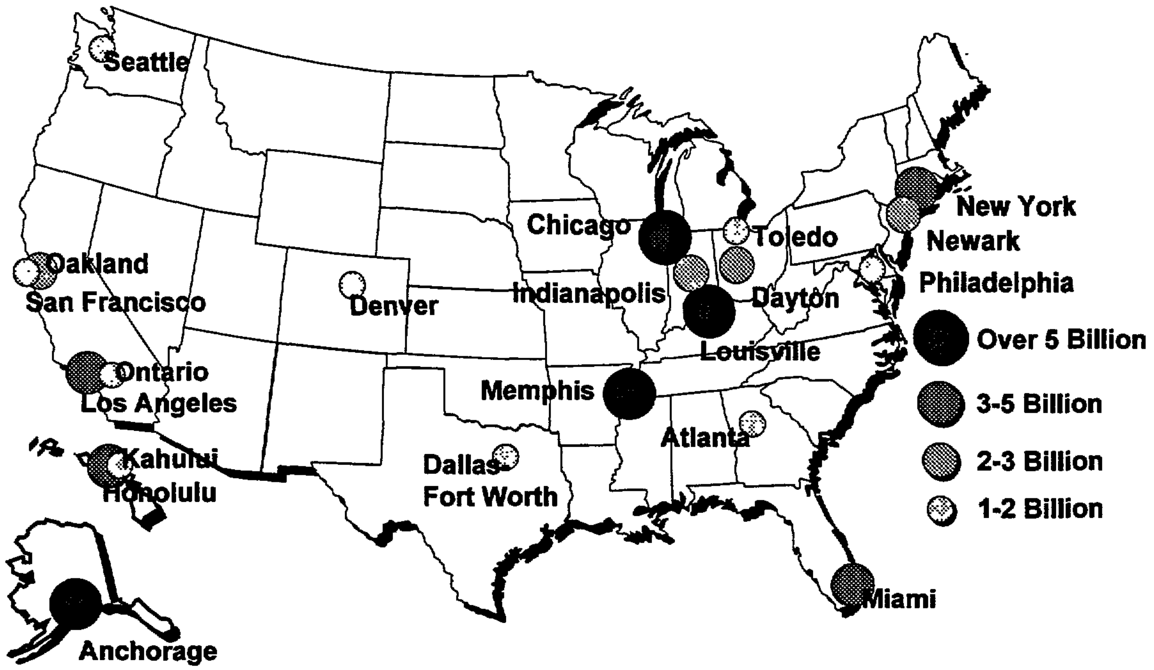
Source: BTS

Revenue by Mode (1991)



Source: BTS

Cargo Airports by Total Gross Landed Weight (in pounds)



Source: FAA DOT/TSC CY93 ACAIS Database

Cargo Airports by Total Gross Landed Weight (in pounds)

Rank	Airport Name	City, State	Total Gross Landed Weight
1	Anchorage Intl	Anchorage, AK	8,525,862,701
2	Memphis Intl	Memphis, TN	7,057,917,624
3	Chicago O'Hare Intl	Chicago, IL	6,603,693,296
4	Standiford Field	Louisville, KY	6,114,359,000
5	Honolulu Intl	Honolulu, HI	4,224,093,100
6	John F. Kennedy Intl	New York, NY	3,916,772,439
7	Miami Intl	Miami, FL	3,607,260,680
8	Los Angeles Intl	Los Angeles, CA	3,270,114,700
9	James M. Cox Dayton Intl	Dayton, OH	2,657,078,520
10	Indianapolis Intl	Indianapolis, IN	2,638,029,850
11	Newark Intl	Newark, NJ	2,348,722,370
12	Metropolitan Oakland Intl	Oakland, CA	2,233,297,370
13	Dallas/Fort Worth Intl	Dallas-Fort Worth, TX	1,937,850,177
14	The William B Hartsfield	Atlanta, GA	1,918,170,100
15	Ontario Intl	Ontario, CA	1,783,409,600
16	Philadelphia Intl	Philadelphia, PA	1,640,460,230
17	Kahului	Kahului, HI	1,612,693,300
18	San Francisco Intl	San Francisco, CA	1,436,535,150
19	Seattle-Tacoma Intl	Seattle, WA	1,417,790,420
20	Toledo Express	Toledo, OH	1,413,167,000
21	Stapleton Intl	Denver, CO	1,242,946,945

Source: FAA DOT/TSC CY93 ACAIS Database

Air Cargo Growth Outlook

- *Small package market is $30 billion a year and growing; biggest players are UPS and Federal Express.*
- *Boeing predicts overall volume will triple by year 2013.*

United Parcel Service

- *1993 revenues of $17.8 billion.*
- *11.5 million packages by truck and 1.5 million packages by air per day*
- *Fleet of 1 79,500 vehicles and 220 aircraft serving 610 airports.*
- *Intermodal moves-by truck to origin airport, by plane to Louisville, unloaded and reloaded, by plane to destination airport, by truck to recipient.*
- *Approximately 400,000 packages transshiped through Louisville per night.*

Federal Express

- *1994 revenues of $8.5 billion.*
- *2 million packages per day*
- *Fleet of 31,000 vehicles and 458 aircraft serving 325 airports.*
- *Intermodal moves-by truck to origin airport, by plane to Memphis, unloaded and reloaded, by plane to destination airport, by truck to recipient.*
- *Approximately 900,000 packages transshiped through Memphis per night.*

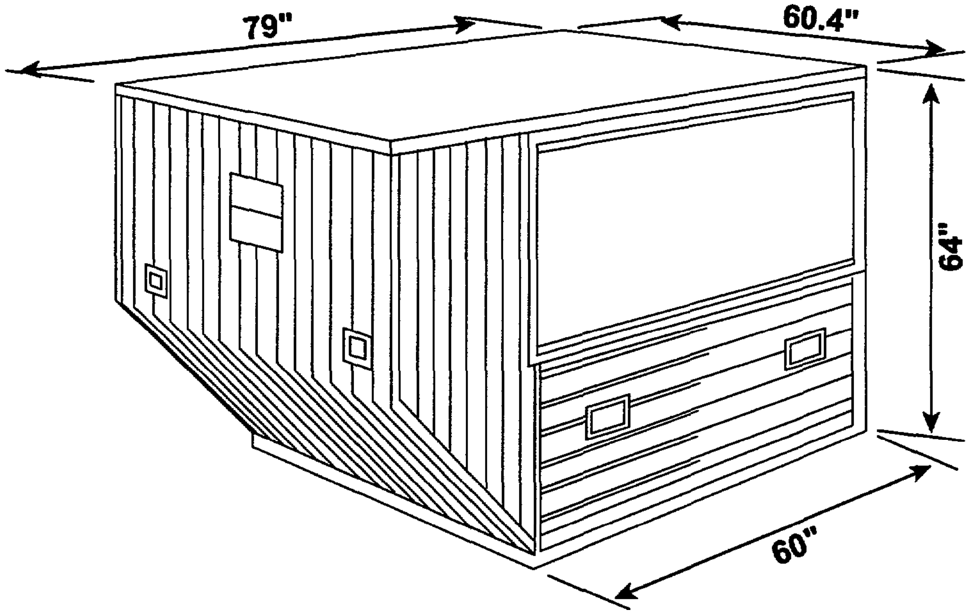
Logistics of Air Cargo Movement

- *Cargo delivered to warehouse by customer, or by shipper (from intermediate collection points); nearly all moves by truck or van.*
- *Cargo sorted for shipment; may be packed into specialized air cargo containers or onto pallets.*
- *From on-airport warehouse: cargo towed to airplane for loading.*
- *From off-airport warehouse: cargo hauled by truck to airport, offloaded and loaded to airplane.*
- *From airplane: offloaded to warehouse for repacking and delivery by truck, or for transshipment by another airplane.*

Intermodal Connections – Strong *Air/Truck Relationship*

- *Trucks are major landside collection and distribution mode.*
- *Some overlap with truck market at short to medium distances.*
- *Some air cargo companies (e.g., United) use trucks rather than airplanes for moves to their hub cities.*
- *Almost all major national LTL trucking companies have air cargo divisions.*

LD3 Air Cargo Container



Source: Airport Planning Manual

Other *Intermodal Connections-impediments*

- *Shipping containers not consistent-different aircraft require different sizes for optimum utilization of space.*
- *Air cargo containers not compatible with other modes-intermodal transfers require re-packing.*
- *Different market (low weight/ high value/time sensitive cargo) than ocean or rail freight; direct connections between these modes not typical.*

Key Issues for Industry

- *EDI and information flow.*
- *Seamless integration of truck and air moves for reliable just in time service.*

PART 2: ITS Applications for Intermodal Freight

Part 2: ITS Applications for Intermodal Freight

Part 2:

ITS Applications for Intermodal Freight

ITS Technologies

- *Radio frequency*
- *Global positioning systems*
- *Weight-in-motion*
- *Electronic data interchange*
- *Automated equipment*
- *Visual imagining*
- *Terminal operations*
- *Load planning*

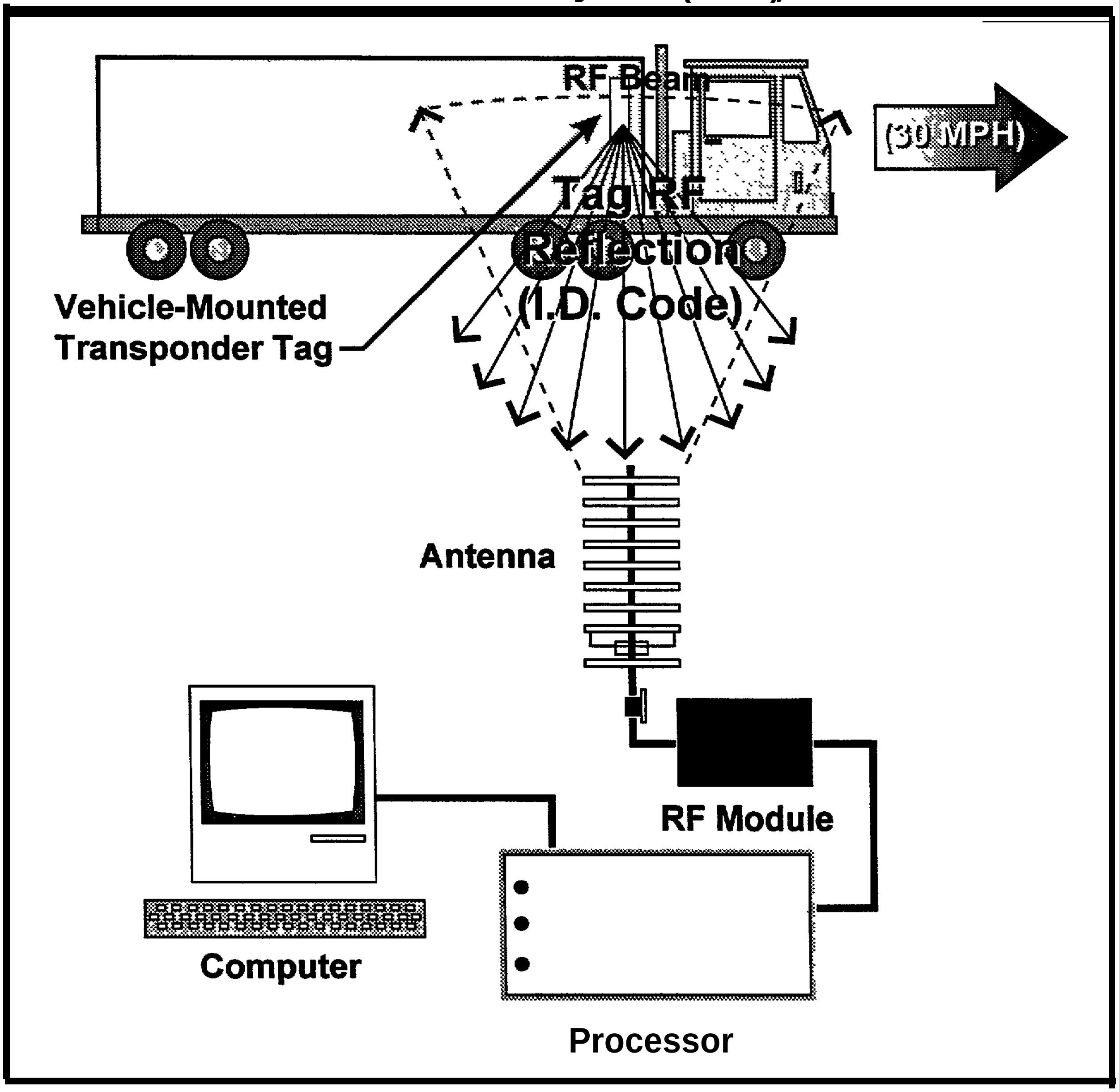
Radio Frequency

- *Inter-terminal*
  - *Toll collection-Smart cards*
  - *AEI-resource location (raiicars, chassis, tractors, containers)*
- *Intra-terminal*
  - *AEI-resource location*
  - *Inventory status*

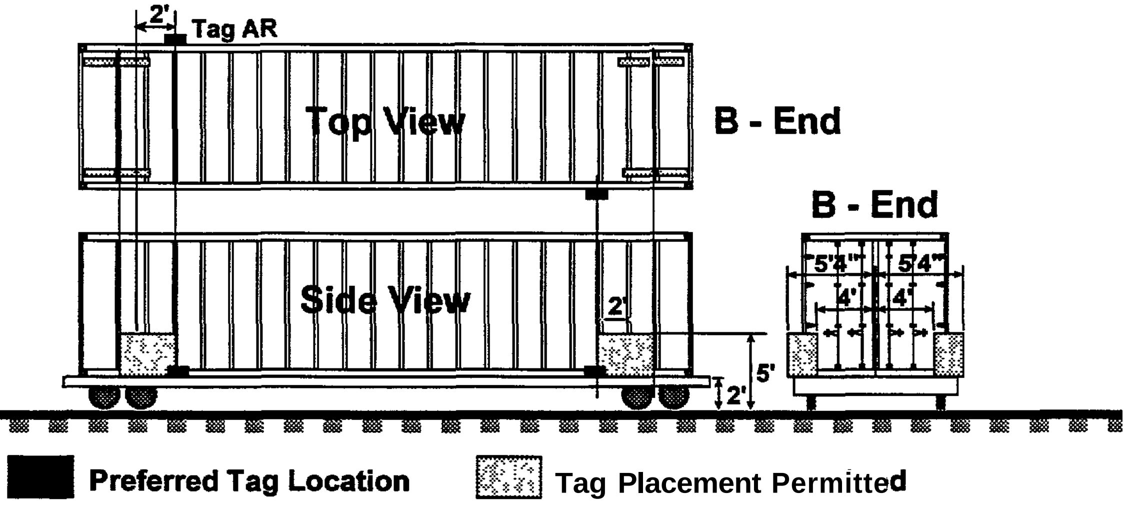
Radio Frequency Benefits

- *Transfer of information while moving less paper*
- *Higher accuracy*
- *Lower gate processing times*
- *Inventory control*

Automatic Container Identification System (A.C.I.)



Automatic Equipment Identification Tag Placement Criteria – Railcar
(By January 1, 1995 All U.S. Railcars will be Tagged)



Source: Association of American Railroads

Automated Equipment

- *Inter-terminal*
  - *Back-up guidance, warning systems*
- *Intra-terminal*
  - *Automatic guided vehicles, (AGVs)*
  - *Partiaiiy-totally automated cranes (RTG, RMC)*

Automated Equipment Benefits

- *Increased safety*
- *Increased productivity per staff*

Weigh-/n-Motion

- *Inter-terminal*
  - *Weight determination while moving for:*
    - *Toll collection*
    - *Roadway weight limitations*
- *Intro-terminal*
  - *Weight determination while moving for:*
    - *Ingate processing, in conjunction with AEI, inspection sampling*
    - *Outgate weight verification*
    - *Lifting - verify weight limitations for top/bottom double-stack trains, ships*

Weigh-in-Motion Benefits

- *Improved flow*
- *Less delay*

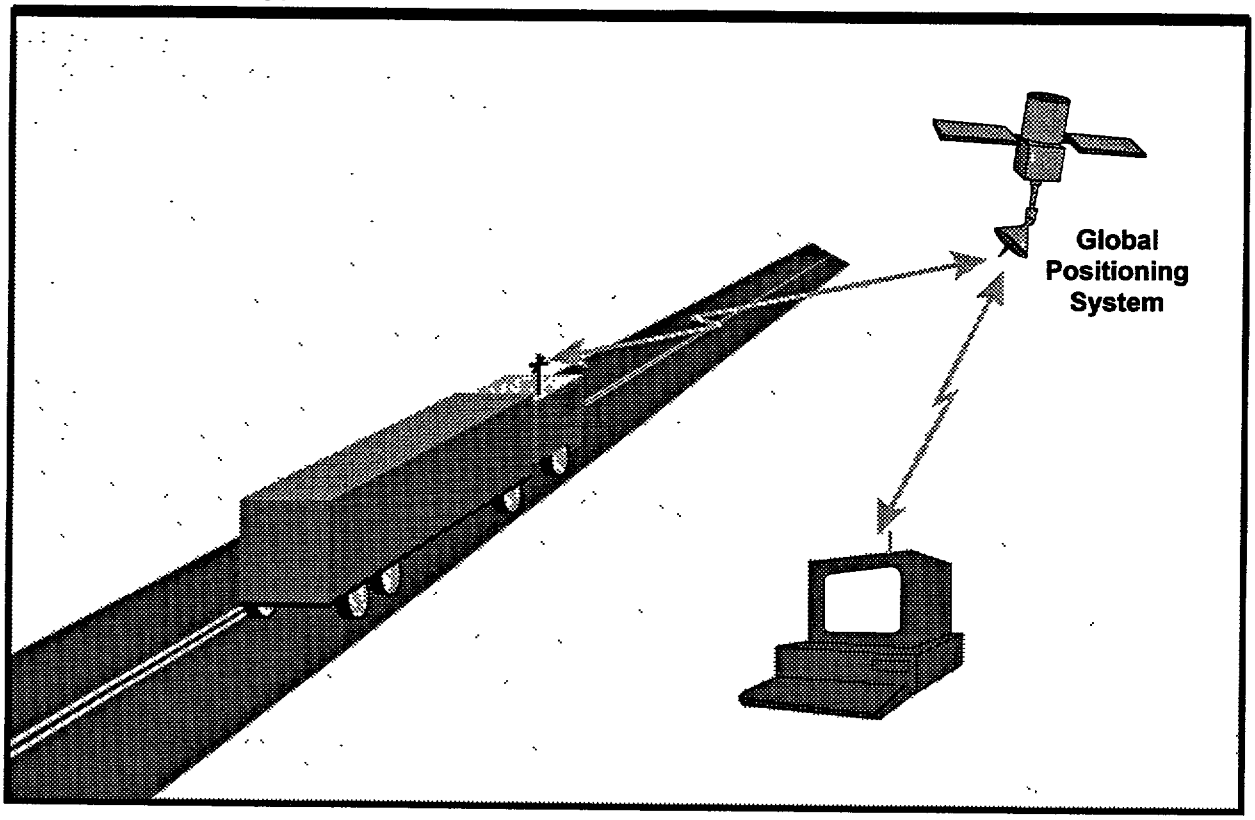
Global Positioning Systems

- *Inter-terminal*
  - *Real-time location identification mapping*
  - *Directional instructions*
  - *Resource movement management*
  - *HAZMAT response*
- *Intra-terminal*
  - *Automated equipment guidance*
  - *Inventory tracking*

Global Positioning Systems Benefits

- *Real-time knowledge of resource location*
- *Improved dispatch efficiency*
- *Improved response to HAZMAT incidents*
- *Improved inventory accuracy*
- *Higher level of automation*

GPS Technology



Electronic Data Interchange

- *Inter-terminal*
  - *Paperless transfer of-*
    - *Invoices*
    - *Manifests*
    - *ETA*
  - *Intra-terminal*
    - *Transmission of work orders*
    - *Transmission of work completion*
    - *Transmission of inventory location*

Electronic Data Interchange Benefits

- *Less paper*
- *Improved accuracy*
- *Quicker, smoother information flow*

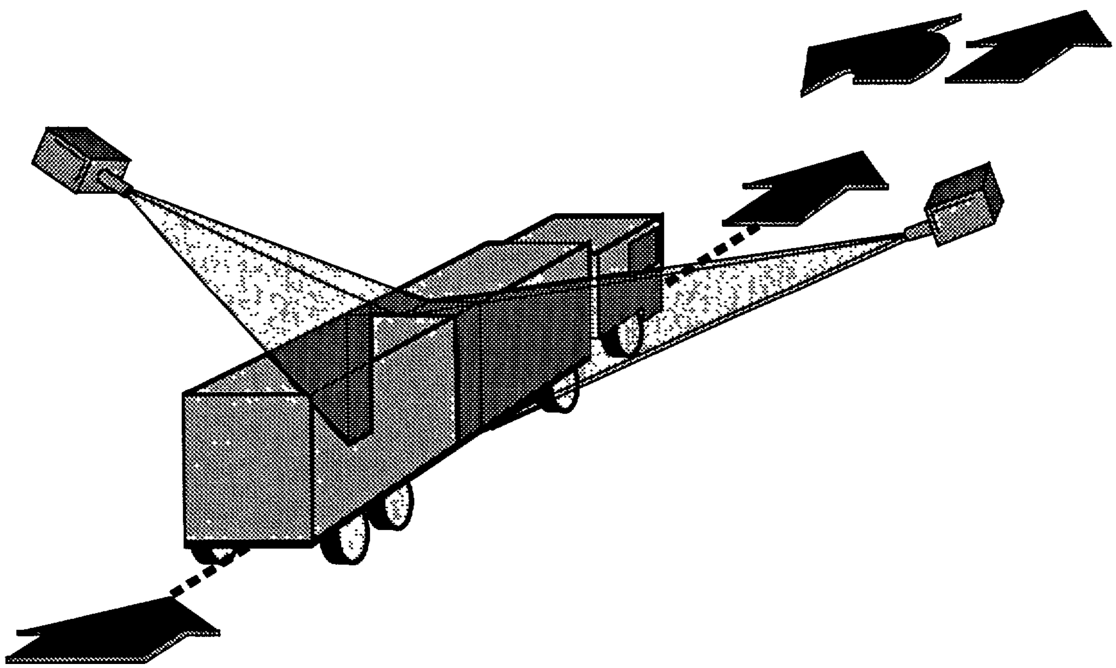
Visual Imaging Technology

- *Inter-terminal*
  - *Traffic monitoring for dynamic highway routing*
  - *Emergency equipment response/routing*
  - *Rail manifest verification (customs)*
- *Intra-terminal*
  - *Inspection*
  - *Container/chassis identification*
  - *Rail manifest verification*
  - *improved lift equipment safety*

Visual Imaging Technology Benefits

- *Permanent record of container condition at inspection*
- *Inventory accuracy*
- *Improved safety*

Automatic Container Inspection (High Speed Visual Imaging)



Source: Vickeman · Zachary · Miller

Terminal Operating Systems

- *Inter-Terminal*
  - *Scheduling/outing inbound and outbound traffic for optimized flow by ail modes*
- *Intra-Terminal*
  - *Identification prioritization of work order*
  - *Planning, optimization of*
    - *Storage*
    - *Shiff Staffing*
    - *Terminal infrastructure, equipment, use*
  - *Accurate Inventory*

Terminal Operating Systems Benefits

- *Better land, equipment use*
- *Improved throughput*
- *Lower cost*

Load Planning Systems

- *Inter-terminal*
  - *Information transfer of train/ship manifest/container position*
  - *Identification of HAZMAT/high priority loads*
- *Intra-terminal*
  - *Optimization of train/ship space*
  - *Generation of list of lifts to TOS system*
  - *Notification to customer of approximate availability for pick-up*

Load Planning Systems Benefits

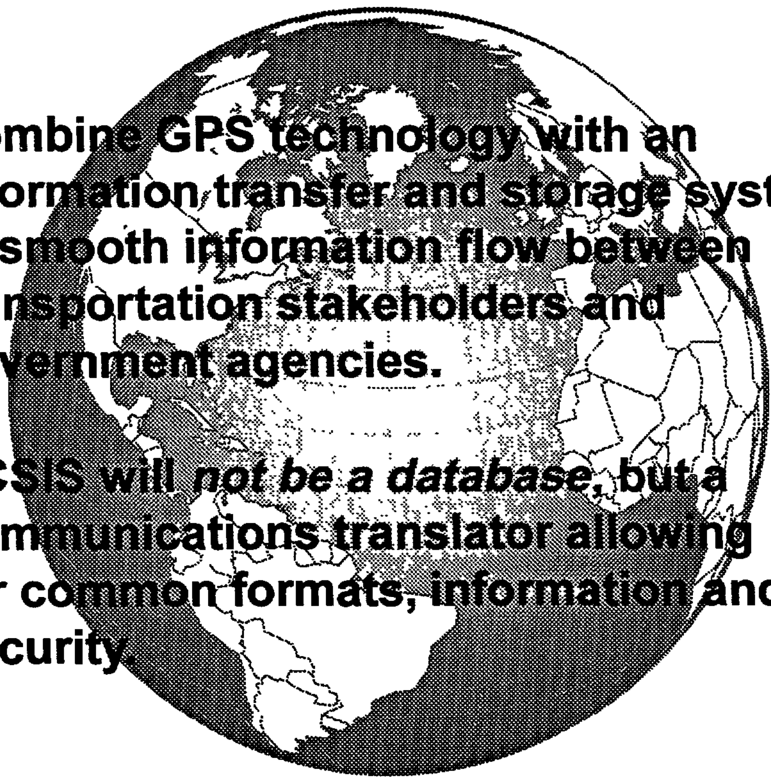
- *Improved resource utilization*
- *Improved planning in and between terminals*
- *Lower cost*

Sandia National Labs

Sandia National Labs

ACSIS: Advanced Cargo Surveillance Information System

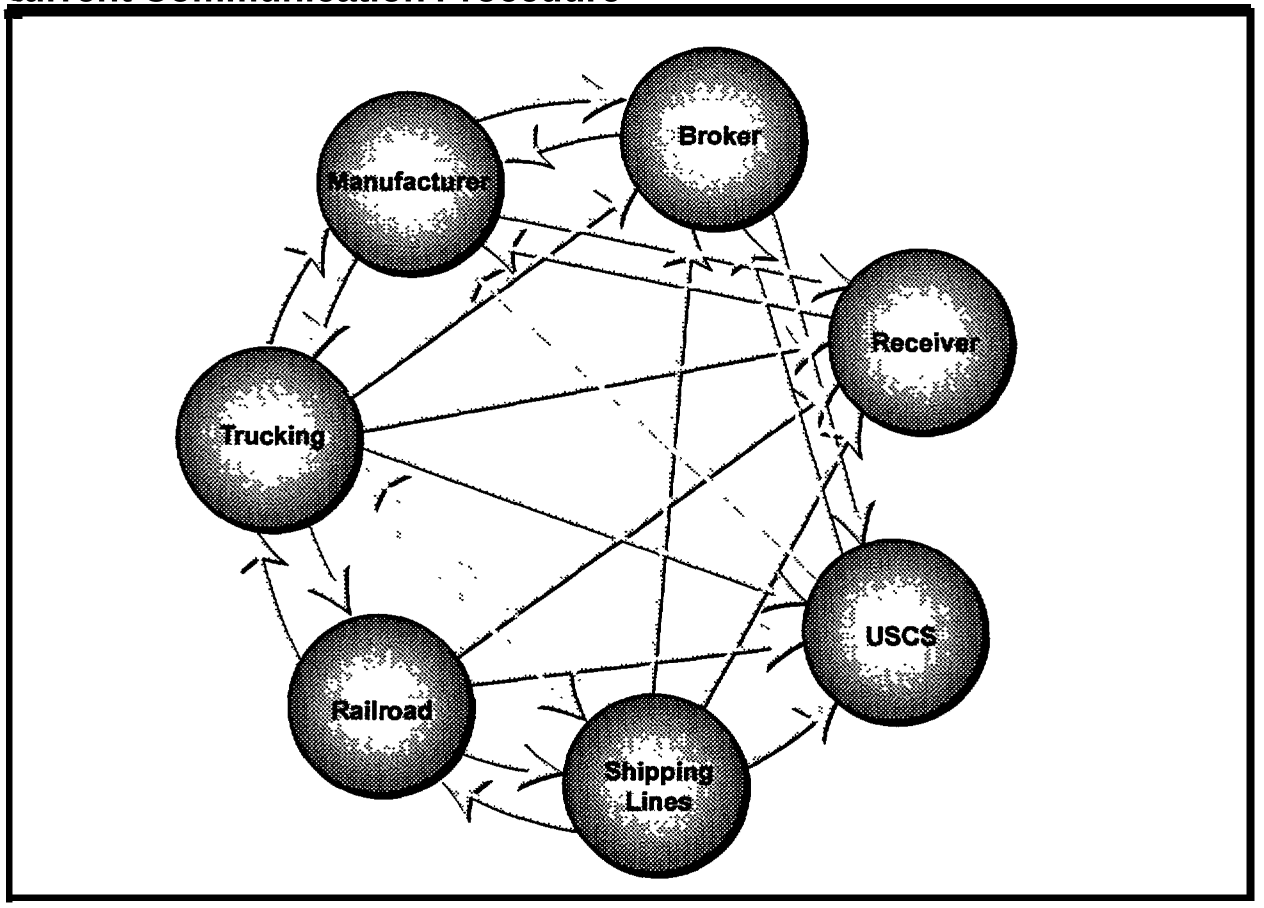
Vision



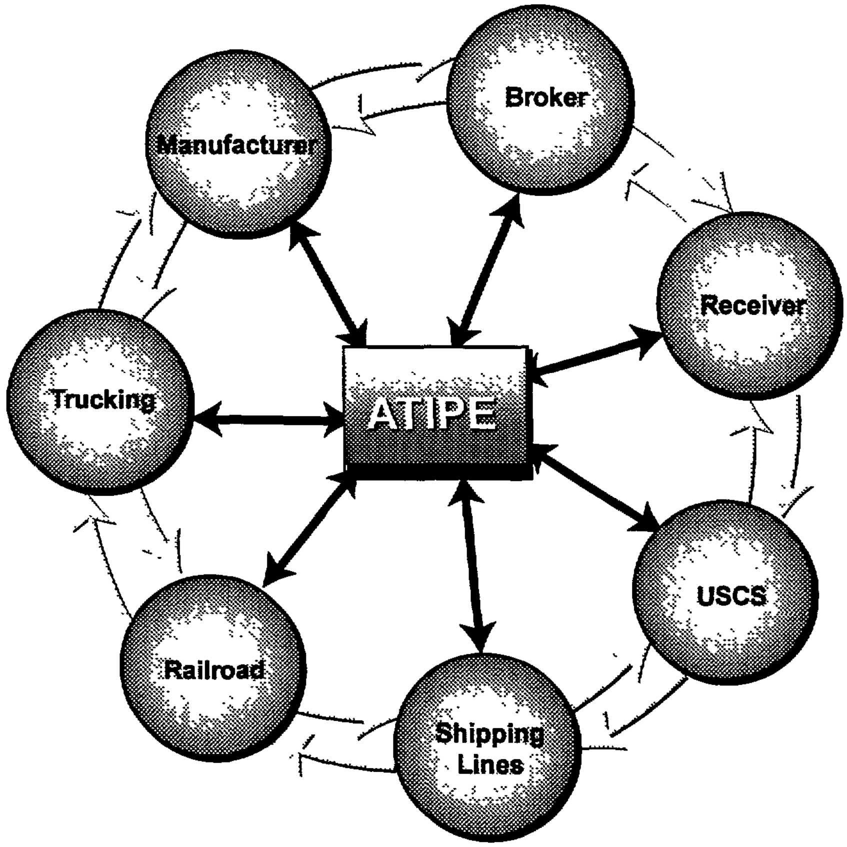
Combine GPS technology with an information transfer and storage system to smooth information flow between transportation stakeholders and government agencies.

ACSIS will *not be a database*, but a communications translator allowing for common formats, information and security.

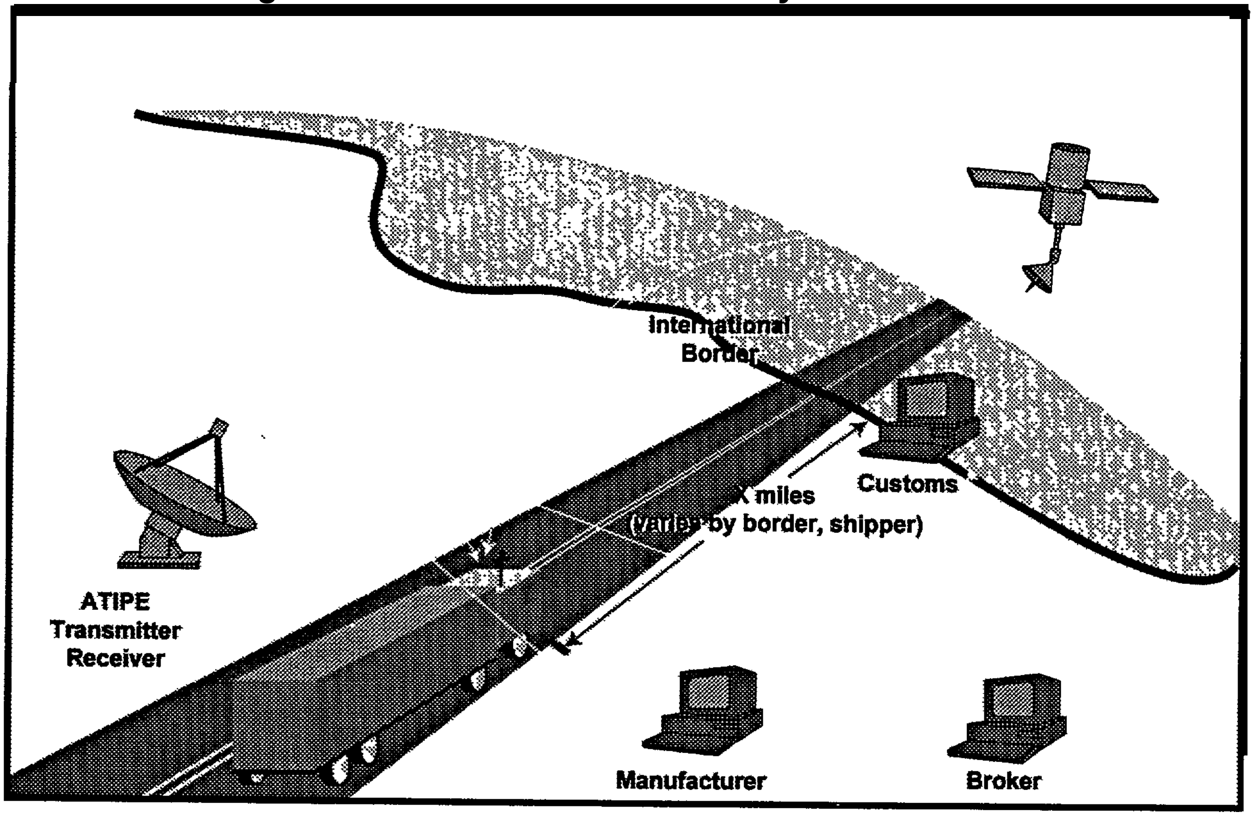
Current Communication Procedure



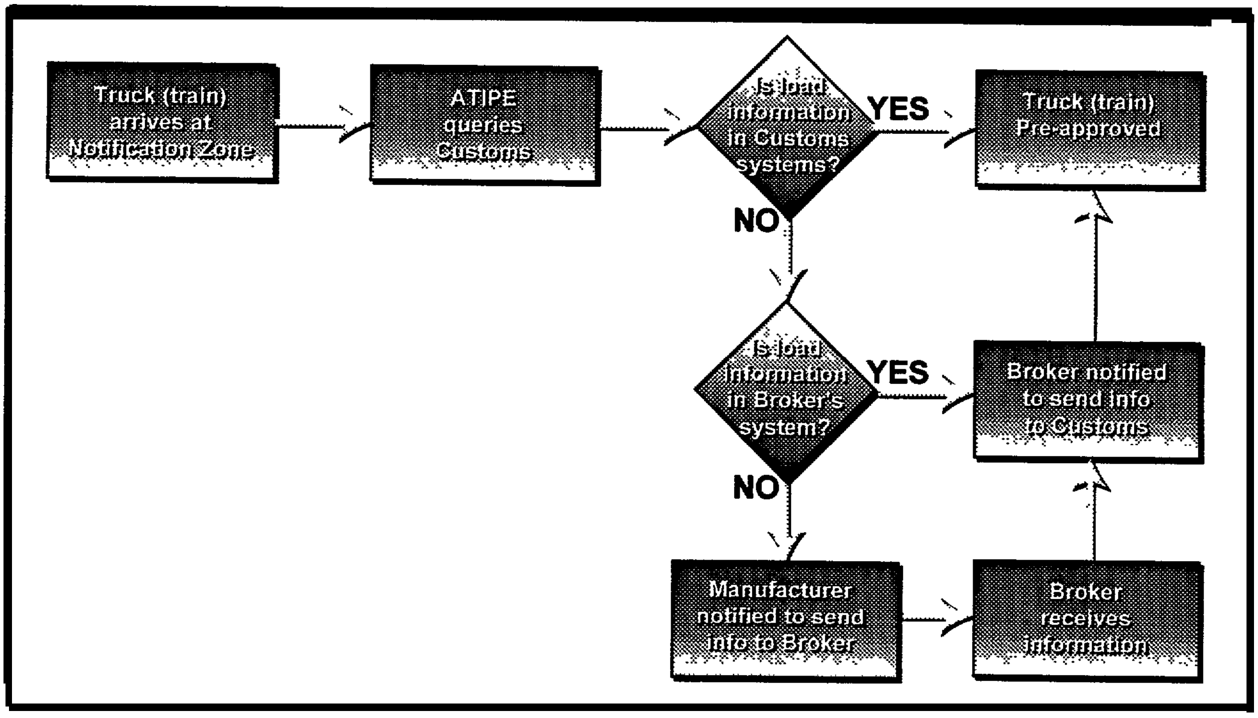
Future Communication Procedure



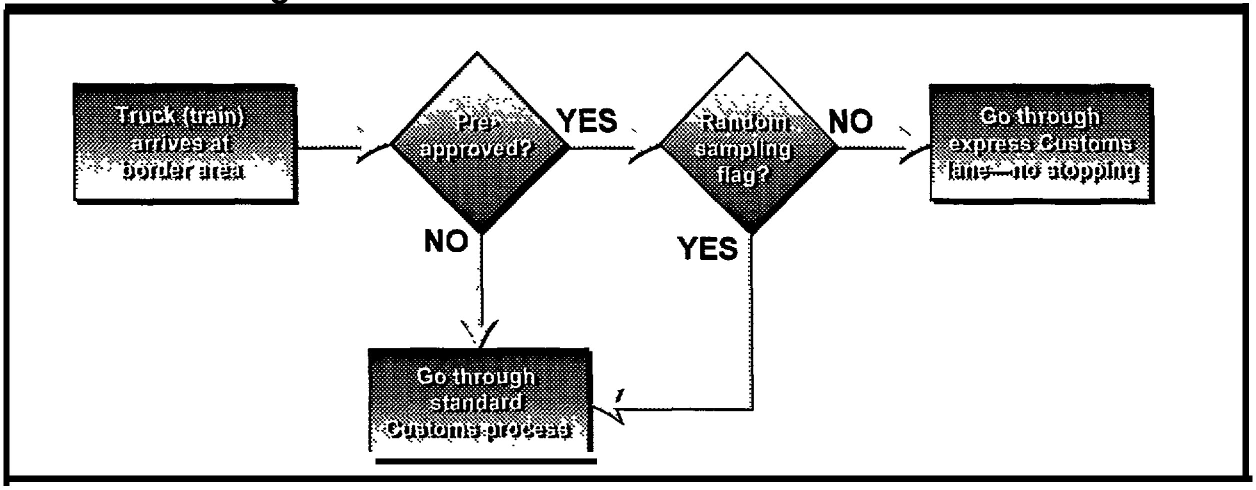
Advanced Cargo Surveillance Information System



Notification Zone



Border Crossing



PART 3: ITS & Intermodal Freight Transportation

Part 3: Intelligent Transportation Systems and Intermodal Freight Transportation

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U.S. Department
of Transportation
**Federal Highway
Administration**

Intelligent Transportation Systems and Intermodal Freight Transportation

DOT-FHWA-JPO-97-008
DOT-VNTSC-FHWA-96-7

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Prepared by

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Volpe National
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Cambridge, MA 02142-1093

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13 ABSTRACT (Maximum 200 words)

The purposes of this paper are to provide background information to the U.S. Department of Transportation's Intelligent Transportation Systems (ITS) Joint Program Office to support a deeper understanding of the business perspectives, operations, and technologies used in the intermodal freight industry, and to suggest courses of Federal action that will improve communications with the commercial intermodal freight sector and enhance the interface between the ITS program and industry initiatives.

This paper describes the various advanced technologies already in use in the intermodal freight transpottation industry and addresses the opportunity for improved communication between the public and private sector regarding technology applications to the freight transpottation system that could enhance the capacity of the system as a whole.

The current public interest in freight transportation policy creates an opportunity to develop a shared vision of the future needs of international intermodal freight transportation in the United States. The Federal government can impact this vision by taking action in the followmg areas:

- Provide Infrastructure Funding to Support Efficiency and Global Competitiveness.
- Support Regional and Corridor Efforts.
- Understand the Freight Sector and Develop a Shared Vision of Technology Benefits.
- Lead Transportation Technology Efforts of Federal Agencies.
- Maintain Commitment to Open ITS Architecture

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PREFACE

This document was prepared for the Federal Highway Administration (FHWA) Intelligent Transportation Systems Joint Program Office (JPO) and presents the findings of a six month study undertaken by Anne Aylward, a senior transportation consultant to the Volpe National Transportation Systems Center (Volpe Center). Michael Onder was the FHWA project manager. The conclusions and recommendations represent the views of the author and not necessarily those of the FHWA.

This report is considered an informal technical document and is intended to improve working level communication. Because of its informal nature, the report may be subject to change as it is reviewed by industry experts and as more information becomes available. It is the author's hope that the report will contribute to dialogue between the Federal government and the intermodal freight transportation industry. If private and public sector can agree on transportation priorities it will be easier to identify advanced information technologies which may contribute to solutions.

Many people have contributed to this report. Managers of intermodal terminals and operations have been generous with their time and candid opinions. Industry associations and committees have welcomed our participation in their meetings and deliberations. Public officials have been open in discussing their concerns and thoughts about opportunities. Their contributions have all enriched this report.

The author wishes to acknowledge these contributions and to thank her colleagues at the Volpe Center who assisted with editing and preparing the report, particularly I. Michael Wolfe and Simon Prensky. All factual errors and omissions remain solely the responsibility of the author.

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC	METRIC TO ENGLISH
LENGTH (APPROXIMATE) 1 inch (in) = 2.5 centimeters (cm) 1 foot = 30 centimeters (cm) 1 yard (yd) = 0.9 meters (m) 1 mile (mi) = 1.6 kilometers (km)	**LENGTH** (APPROXIMATE) 1 millimeter (mm) = 0.04 inch (in) 1 centimeter (cm) = 0.4 inch (in) 1 meter (m) = 3.3 feet (ft) 1 meter (m) = 1.1 yards (yd) 1 kilometer (km) = 0.6 miles (mi)
AREA (APPROXIMATE) 1 Square inch (sq in, in2) = 6.5 square centimeters (cm2) 1 square foot (sq st, ft2) = 0.09 square meter (m2) 1 square yard (sq yd, yd2) = 0.8 square meters (m2) 1 square mile (sq mi, mi2) = 2.6 square kilometers (km2) 1 acre = 0.4 hectare (ha) = 4,000 square meters (m2)	**AREA** (APPROXIMATE) 1 square centimeter = 0.16 square inch (sq in, in2) 1 square meter (m2) = 1.2 square yards (sq yd, yd2) 1 square kilometer (km2) = 0.4 square mile (sq mi, mi2) 10,000 square meters (m2) = 1 hectare (ha) = 2.5 acres
MASS - WEIGHT (APPROXIMATE) 1 ounce (oz) = 28 grams (gm) 1 pound (lb) = .45 kilogram (kg) 1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)	**MASS - WEIGHT** (APPROXIMATE) 1 gram (gm) = 0.036 ounce (oz) 1 kilogram (kg) = 2.2 pounds (lb) 1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons
VOLUME (APPROXIMATE) 1 teaspoon (tsp) = 5 milliliters (ml) 1 tablespoon (tbsp) = 15 milliliters (ml) 1 fluid ounce (fl oz) = 30 milliliters (ml) 1 cup (c) = 0.24 liter (l) 1 pint (pt) = 0.47 liter 1 quart (qt) = 0.96 liter (l) 1 gallon (gal) = 3.8 liters (l) 1 cubic foor (cu dt, ft3) = 0.03 cubic meter (m3) 1 cubic yard (cu yd, yd3) = 0.76 cubic meter (m3)	**VOLUME** (APPROXIMATE) 1 milliliter (ml) = 0.03 fluid ounce (fl oz) 1 liter (l) = 2.1 pints (pt) 1 liter (l) = 1.06 quarts (qt) 1 liter (l) = 0.26 gallon (gal) 1 cubic meter (m3) = 36 cubic feet (cu ft, ft3) 1 cubic meter (m3) = 1.3 cubic yards (cu yd, yd3)
TEMPERATURE (EXACT) OC = 5/9(oF - 32)	**TEMPERATURE** (EXACT) OF = 9/5(oC) + 32

QUICK INCH-CENTIMETER LENGTH CONVERSION

INCHES	0	1	2	3	4	5								
CENTIMETERS	0	1	2	3	4	5	6	7	8	9	10	11	12	13

QUICK FAHRENHEIT-CELSIUS TEMPERATURE CONVERSION

OF	-40	-22	-4	14	32	50	68	86	104	122	140	158	176	194	212
OC	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and measures. Price $2.50. SD Catalog No, C13 10286.

Updated 8/1/96

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The purpose of this paper is two fold: First to provide background information to the U.S. Department of Transportation's Intelligent Transportation Systems Joint Program Office (JPO) to support a deeper understanding of the business perspectives, operations, and technologies used in the intermodal freight industry. Second, to suggest courses of Federal action that will improve communications with the commercial intermodal freight sector and enhance the interface between the ITS program and industry initiatives.

The Problem: Since the 1991 passage of the Inter-modal Surface Transportation Efficiency Act (ISTEA) the Federal government has invested extensively in development of the Intelligent Transportation System (ITS), applying advanced technologies to enhance the effectiveness and efficiency of the nation's transportation system. The Commercial Vehicle Information Systems Network program (CVISN) is an important component of the ITS program.

In the past decade, responding to the requirements of the emerging global marketplace, shippers have pressed for improved transportation service at lower cost. Many transportation service providers have turned to new technologies to meet shipper needs. Application of advanced technology has transformed the freight transportation industry, as individual companies have invested in state-of-the-art technology to maintain profitability in an increasingly competitive international marketplace.

This paper describes the various advanced technologies already in use in the intermodal freight transportation industry which must be considered during the deployment of the ITS CVISN program. It addresses the opportunity for improved communication between the public and private sector regarding technology applications to the freight transportation system that could enhance the capacity of the system as a whole.

Research Methodology: This paper is an informal technical document intended to improve working level communication between the Federal government and industry about the application of advanced information technologies to intermodal freight transportation.

The findings of the paper are based on:

- Extensive interviews -- formal and informal -- with industry representatives and staff of Federal, state, and local government transportation agencies;
- Site visits to inter-modal terminals and freight facilities to view technology;
- Participation in industry association and committee meetings and deliberations; and
- Review of technical literature and industry press.

Summary of Findings:

The efficient movement of freight is essential to the economy of the United States and to the quality of life and standard of living of its citizens. In the last 25 years, the United States has moved into an increasingly global economy. Imports and exports now comprise twenty percent of the U.S. gross domestic product and are expected to triple over the next 25 years. If United States products are to compete effectively in international markets, the nation must continue to support an efficient, cost-effective freight transportation system. To maximize the capacity of the nation's transportation infrastructure, it is important to plan and manage transportation assets as a *system.*

The modes of transportation that comprise the U.S. transportation system developed independently. Each mode is a separate system that consists of a network of line-haul infrastructure, terminals that connect with other modes, and vehicles that carry cargo. Today the modes operate in parallel and sometimes cooperatively, but each largely retains its own distinct ownership, operating patterns, and financing sources.

The inter-modal "system" is in fact not a system at all, but a collection of systems that have been variously linked together. Managers of each mode understand their own operation but no one is responsible for integrating the overall system. Information and communication technologies have enormous potential to strengthen the links between the separate modal systems.

Intermodal interchange takes place at physical points of transfer, such as terminals, sidings, and border crossings where freight and equipment are transferred from one mode to the next. The physical interchange should not be allowed to impede intermodal transport as a result of poor access, incompatible equipment, etc. Intermodal transportation also depends upon an electronic interface to transmit the information required to transfer the cargo from its origin to destination. Information technologies and telecommunications are employed in innovative ways to improve customer service and achieve transport cost savings. A market niche has developed for third party operators to create services in intennodal transportation that benefit both the shipper and the transportation provider by linking the modal systems.

National investment in both the physical links that allow cargo to move between modes and the technology links that enable the intermodal exchange of information is critical. Advanced information and communication technologies applied across the intermodal system offer important opportunities to increase system capacity.

Shippers' transportation requirements have changed in response to increasing competition. Shippers have pressed for cost reductions and service improvements. Shipper requirements include frequent, reliable, and fast service; global service and management capacity; door-to-door intermodal service; dedicated (or available pooled) equipment; full logistics services including cargo tracking, just-in-time inventory management, warehousing and distribution; and the ability to exchange information electronically to handle bookings, cargo status, billing and other data interchange.

The transportation industry's response to these shipper requirements has resulted in higher quality value-added service. Deregulation has allowed carriers to be more responsive to customers and to develop individualized services. The most important current trends include movement toward end-to-end service; supply chain integration; new partnerships and alliances; outsourcing of logistics functions; sharing of equipment and other assets; paperless exchange of information; and adjustment to the changing role of government in freight transportation. In the last decade enormous savings have been achieved through deregulation and greater efficiency in the freight and logistics systems. Terminal operators and third party companies have developed services that link the modal systems.

Advanced technology has revolutionized transportation. Transportation service providers widely use advanced technologies to identify and track cargo and equipment in real time and to transact business electronically. Industry has adopted technology solutions to solve specific business problems. Before any investment is made in technology, it is critical that the business problem to be solved be clearly understood so that the technology selected will be appropriate to improve the situation.

The intermodal freight industry has set the pace in transportation for use of advanced technology. Private freight carriers have made substantial use of information technology to enhance the productivity of their own operations. These technological systems were initially developed as *closed corporate systems* without regard to the efficient operation of the broader intermodal freight system. More recently, these systems have begun to provide links with customers and intermodal partners.

Exchangingfreight information electronically, carriers and shippers are able to automate and integrate a broad range of billing, data entry, and cargo tracking functions. Automation has allowed carriers to enhance their transportation service by providing the shippers and multiple trading partners with real-time information on the movement of the vehicle and the cargo.

Advanced communication technologies have transformed intermodal transportation in the past decade, however the question of *system-wide data interchange* remains problematic. System interoperability and the compatibility of existing systems and the ITS CVISN program will be key.

The traditional ***role of the Federal government in freight transportation*** is the funding of infrastructure for some modes and the execution of regulatory, safety and environmental oversight of the system. Since the passage of ISTEA in 1991 the Federal government has aggressively engaged in a broader partnership in the efficient movement of freight. Both public sector and industry leaders have made a major commitment to outreach, education and partnership. The current public sector interest in freight transportation is an opportunity to create a shared vision of the future needs of international intermodal freight transportation in the United States.

The U.S. Department of Transportation (DOT) has responsibility for providing *leadership for technology applications to transportation* and for encouraging technologies which allow the seamless exchange of information between modes and between the public and private sectors.

Summary of Recommendations

Private freight carriers have made substantial use of information technology to enhance the productivity of their own operations. Public investment in ITS systems can further improve the productivity and safety of intermodal freight operations. The current public interest in freight transportation policy creates an opportunity to develop a shared vision of the future needs of international inter-modal freight transportation in the United States. The Federal government can impact this vision by taking action in the following areas:

Provide Infrastructure Funding to Support Efficiency and Global Competitiveness. The private sector cannot provide seamless intermodal freight transportation services to support domestic and international trade without the underlying physical and information infrastructure provided by the Federal government. This is a crucial Federal role in transportation.

> ***Action:*** Build on the programs begun under ISTEA by providing funding for the physical infrastructure essential to the intermodal transportation system, including terminal access roads and port navigation channels.
>
> ***Action:*** Provide sufficient funding to support federal programs essential to the information infrastructure including weather information, the global positioning system, navigation information, and the full communication spectrum.

Support Regional and Corridor Efforts. Intermodal freight transportation is international in scope. Supporting the smooth flow of freight is in the national interest. Many issues transcend the local or state level. It is important to sustain corridor ("truck shed") activities such as those underway in the I-75 Advantage program, the I-95 Corridor and the HELP program and to fully involve the freight community, particularly port and terminal operators in those efforts.

> ***Action:*** Encourage, facilitate and participate in regional and corridor efforts. Establish regular funding mechanisms for these public-private alliances.

Understand the Freight Sector and Develop a Shared Vision** of* ***Technology Benefits. The complexity of the freight sector, the multitude of stakeholders involved, and their divergent priorities have created a conflicted vision of what the freight sector might gain from ITS technologies. The Federal government is positioned to provide leadership, to develop a shared vision of the capabilities of technology applied to global transportation and its benefit to the nation, to the private sector and to state and local governments, and to incorporate into this vision knowledge derived by Department of Defense (DOD) as a major user of the system. To effectively meet the needs of the intermodal freight transportation sector it is necessary to understand freight transportation operations and priorities, including current awareness about the state of the art applications of information technologies.

Action: Participate actively in industry meetings, activities and working groups.

Action: Provide the Office of Intermodalism with the necessary authority and funding to serve as an effective advocate for intermodal freight issues, regardless of mode, and as a technical resource for the ITS Joint Program Office in addressing private sector ITS issues.

Action: Work with representatives of the intermodal freight industry to create an Intermodal Freight Carrier Leadership Council to meet with the Secretary quarterly and provide input on the impact of the ITS program on the freight industry, as well as such other freight policy issues as may be of mutual interest.

Lead Transportation Technology Efforts of Federal Agencies. Transportation technology initiatives which impact the movement of inter-modal freight are underway in several Federal agencies. The current regulatory and reporting system for commercial transportation operators is complex and duplicative. ITS offers significant opportunities for single point electronic delivery of information to government agencies.

Action: Lead Federal transportation technology policy initiatives, particularly the work of the National Science and Technology Council's Transportation Committee.

Action: Coordinate transportation technology policy amongst Federal agencies, particularly border crossing initiatives.

Action: Coordinate DOT/DOD/industry efforts to adopt interoperable transportation technologies, particularly for tagging and tracking of cargo.

Action: Support Commercial Vehicle Operations (CVO) operational and corridor tests.

Action: Use technology to simplify the current regulatory and reporting system for commercial inter-modal operators by providing single point electronic delivery of information to Federal and state agencies.

Maintain Commitment to Open ITS Architecture. Participants in inter-modal transportation are reluctant to absorb the cost of implementing technology if there is a fear that the technology adopted will rapidly become obsolete or incompatible. This is of particular concern in the interface between private sector and government operated systems, e.g. toll facilities and border crossings.

Action: Facilitate private sector efforts to adopt industry-wide performance standards and data protocols.

Action: Address issues of data exchange and interoperability among commercial users and Federal agencies including the Departments of Transportation and Defense and the U.S. Customs Service.

Action: Involve port and intermodal freight terminal operators in ITS/CVIS deployment to identify opportunities and problems at the interface between ITS and the existing intermodal freight systems.

GLOSSARY OF INTERMODAL ACRONYMS

AAPA	Association of American Port Authorities
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACTS	Automated Train Control Systems
AEI	Automatic Equipment Identification
ANSI	American National Standards Institute
ATA	Air Transport Association of America
ATA	American Trucking Associations
ATCS	Automated Train Control Systems
ATS	Automatic Train Supervision
AVI	Automated Vehicle Identification
CAA	Clean Air Act
CLM	Car Location Message
COFC	Container on Flat Car
CVISN	Commercial Vehicle Information Systems and Networks
c v o	Commercial Vehicle Operators
DSRC	Dedicated Short Range Communications
ECDIS	Electronic Chart Display and Information Systems
ED1	Electronic Data Interchange
EDIFACT	Electronic Data Interchange for Administration, Commerce and Transportation
EMP	Equipment Management Program
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Rail Administration
GPS	Global Positioning Satellites
IATA	International Air Transport Association
ICTF	Inter-modal Container Transfer Facility
IFTA	International Fuel Tax Agreement
ILA	International Longshoremen's Association
ILWU	International Longshoremen's and Warehousemen's Union
IMC	Inter-modal Marketing Company
IMO	International Maritime Organization
ISA	International Shipping Agreement
ISTEA	Intermodal Surface Transportation Efficiency Act
ITS	Intelligent Transportation Systems
ITV	Intransit Visibility
JIT	Just In Time (delivery)
LAN	Local Area Network
LCL	Less than Container Load
LEO	Low Earth Orbit
LTL	Less than Truckload
MACS	Mainline Automated Clearance System
MARAD	Maritime Administration

MPO	Metropolitan Planning Organization
NACS	North American Container System
NSTC	National Science and Technology Council
NVOCC	Non-Vessel Owning Common Carrier
TDCC	Transportation Data Coordinating Committee
TEU	Twenty Foot Equivalent Unit (a container size)
TOFC	Trailer on Flat Car
TOPAS	Terminal Operators and Port Authorities Subcommittee (of TDCC)
U. S. DOD	United States Department of Defense
U. S. DOT	United States Department of Transportation
VAN	Value Added Network
VTS	Vessel Traffic Systems

I. INTRODUCTION

Since the passage of the Intermodal Surface Transportation Efficiency Act in 1991, the U.S. Department of Transportation has invested in development of a national Intelligent Transportation System (ITS). Recognizing that the nation's transportation system, particularly for the movement of freight, encompasses multiple modes, the U. S. DOT has requested this exploration of the relationship of the ITS program to the nation's intermodal freight transportation system.

The purpose of the paper is twofold:

> **(1) Educational:** to provide background information to the U.S. Department of Transportation's Intelligent Transportation Systems (ITS) Joint Program Office (JPO) to support a deeper understanding of the business perspectives, operations, and technologies used in the intermodal freight industry.
>
> **(2) Prescriptive:** to suggest courses of Federal action that will improve communications with the commercial intermodal freight sector and enhance the interface between the ITS program and industry initiatives.

Efficient, effective and safe transportation plays a key role in the U.S. economy and national security. The transportation system provides mobility for the nation's commerce. It provides access to raw materials, labor and markets and ensures shippers the means to reach regional, national and international markets at competitive costs. The goal of our transportation policy is to provide mobility for passengers and freight, regardless of the mode.

American businesses are the primary consumers of freight transportation services. In an increasingly global economy, American business must compete internationally. Freight transportation is a key component of the logistics system that supports international trade. American companies must establish efficient distribution systems to compete effectively. Distribution costs can be as much as 30%~40% of a product's cost and in the past decade companies have made every effort to decrease distribution costs while requiring improved performance from transportation service providers.

Global trade is projected to nearly triple in the next 25 years. Environmental and fiscal resources are limited. If the nation is no longer willing to construct vast new infrastructure, the existing infrastructure must be managed more efficiently to create additional capacity. The system works only as well as its weakest link. New investment should focus on improving the system as a whole, regardless of mode. Advanced information and communication technologies applied consistently across the intermodal system offer important opportunities to increase system capacity.

In 1991, with the passage of the Intermodal Surface Transportation and Efficiency Act (ISTEA), Congress focused national transportation priorities on Intermodalism and on Intelligent Transportation Systems (ITS):

Intermodalism describes an approach to planning, building, and operating transportation that emphasizes optimal utilization of transportation resources and connections between modes. The focus of this paper is intermodal *freight* activity, although it is important to recognize that with the passage of ISTEA, the term intermodal was broadened to include intermodal passenger movements. An intermodal freight movement is the coordinated and sequential use of two or more modes of transportation for the completion of a trip, where the responsibility is usually assumed, or coordinated by, a single party. Intermodal freight moves door-to-door from shipper to consignee, optimizing its use of transportation modes, involving ocean, air, rail or highway as best suited to the customer's requirements.

Intelligent Transportation Systems (ITS) similarly take an integrated approach to transportation, linking individual transportation elements -- the vehicle, the infrastructure, and the user -- and joining them through use of information and communication technologies into a single system. ITS offers the opportunity to optimize use of our existing transportation system, generating additional capacity from the existing physical infrastructure. The Federal program began as the Intelligent Vehicle Highway System. Its name was changed to recognize the importance of a systemic intermodal perspective.

In the past decade intermodalism has grown dramatically. Doublestack trains, intermodal terminals and other hardware improvements have provided enormous efficiencies to users of the nation's transportation system. Modifications to physical infrastructure will continue, particularly at the links between modes. However it appears that the greatest opportunity for system improvements over the next three decades will come from advances in micro-electronics. This will appear in improved use of communications and data accuracy.

The U.S. Department of Transportation (DOT) plays two significant roles with respect to the application of advanced information technology to transportation:

The first role is to provide technology focus to the transportation system, to promote efficiency and consistency across modes. This has been the focus of work by the Transportation R&D Committee of the National Science and Technology Council (NSTC). The Committee, chaired by Deputy DOT Secretary Mortimer Downey, has called for an interagency task force to identify and prioritize transportation information technology topics, cutting across modes and markets and to propose a set of targeted investigations. The cross-cutting topics proposed for examination include:

- Transportation Information Infrastructure Vulnerability and Reliability;
- Data Communications and Spectrum Requirements;
- Global Navigation, Positioning and Tracking Systems;
- Incident Management and Emergency Response;

- Transportation Related Weather Service Requirements;
- Global Harmonization of Standards and Technology; and
- Deployment Decision and Planning Knowledge Base

It is critical that U. S. DOT continue to provide leadership in this area.

DOT's second role is to encourage interoperability and a seamless interface of information technology *between modes and between DOT, DOD, and commercial transportation operations.* This paper focuses on this second role. Its particular focus is the relationship of the Federal ITS program to intermodal freight transportation. It addresses:

- The current extent of deployment of advanced information and communication technologies in intermodal freight transportation.

- The potential contribution of the Federal government's ITS initiative to the efficient movement of intermodal freight and the need to include inter-modal freight activities in the program.

This paper builds on the work of the National Commission on Inter-modal Transportation, recent work completed for the Federal Highway Administration by Cambridge Systematics on the Impediments to Intermodal Transportation, and the strategic work of the ITS America Intermodal Task Force. It draws on the private sector efforts of groups such as the Intermodal Association of North America's Electronic Business Committee and the X1 2 Transportation subcommittee of the American National Standards Institute (ANSI).

II. FREIGHT TRANSPORTATION

Freight transportation service in the United States is largely provided by the private sector. This is in sharp contrast to passenger transportation, where the Federal government is actively involved in nearly all aspects of the system. The traditional role of the Federal government in freight transportation has been to provide infrastructure funding through modal trust funds and to tax and regulate use of the system.

Since the passage of ISTEA in 199 1, public sector planners and policy makers have increasingly recognized the importance of freight movement and searched for opportunities to create new partnerships and to streamline the public sector presence in freight movement. Government officials at the Federal, state, and metropolitan levels have initiated efforts to better integrate freight transportation policy and planning into their programs. Leaders in the freight sector have also recognized the importance of closer cooperation and have initiated efforts in major metropolitan areas to establish freight stakeholders networks to work with MPO and state officials.

The nation's freight system has developed mode by mode over the last 300 years as geography, history and technology have offered new opportunities for economic development. Managers of each mode understands their own operations but no one is responsible for integrating the overall system. Price integrates the development and use of the system through corporate initiative. The development and current status of this modal transportation system are described below.

A. Background: Components of the Freight Transportation System

The coastal waterways and river systems were the backbone of colonial transportation; the 19th century saw the development of the canal and transcontinental railroad systems; the 20th century brought highway and aviation transportation. Today these disparate modes operate in parallel and sometimes cooperatively, but each largely retains its own distinct ownership and operating patterns. Each mode is a system which is comprised of:

- A network of infrastructure: roads, rails, waterways;
- Terminals where cargo transfers between modes; and
- Vehicles which carry cargo
- Each mode also has its own Federal and state regulatory framework and funding system.

The components of each modal system are described below.

(1) Maritime Transportation:

The Federal role in transportation began in 1789 with harbor improvements. Since then, the nations' waterways and shipping channels have been regularly maintained by the U.S. Army Corps of Engineers. Since 1986 channel maintenance costs have been paid from the Harbor Maintenance Trust Fund which is financed by ad valorem cargo user fees.

Terminals in the maritime transportation system are variously owned by the private sector (primarily bulk terminals) or state or local authorities (primarily container and general cargo terminals). Public terminals may be operated by the local port authority, by a private terminal operator, or by an ocean shipping line.

The deregulation of the shipping industry, trends toward consolidation of ocean carriers, merger of Class 1 railroads, and introduction of larger ships and of stack trains have all resulted in the concentration of commerce in a limited number of large and highly competitive “load center” ports. Marine ports, by definition, are located on the coast and often at the center of an urban area. As port areas become more congested the development of connected inland terminals and sorting/distribution yards may become more economically viable.

The ships and barges calling at the nation’s ports are all privately owned. Trade between U.S. ports is restricted to U.S. vessels. Trade to international ports is open to international vessels Regulatory oversight of maritime transportation is divided among several Federal agencies. The Coast Guard has regulatory authority for waterway management, while the Federal Maritime Commission has regulatory oversight of maritime agreements. U.S. Customs and the Immigration and Naturalization Service (INS) have jurisdiction over international cargo and passenger entry, respectively.

(2) Rail Transportation:

The rail system developed to meet the needs of the nation’s westward expansion beginning in the 1820’s. The Federal government encouraged rail development by granting rights-of-way and adjacent land development rights. The rail industry was substantially deregulated by the Staggers Act in 1980. U.S. DOT has continuing regulatory and safety responsibilities. The introduction of doublestack container trains in 1984 transformed the economics and performance of rail transportation of containers and helped spur intermodal traffic growth. Intermodal has been a growth area for railroads in the past decade. However it is still a small part of the industry’s overall business and for most railroads has shown a thin profit margin.

Today the entire Class 1 rail system -- track, trains, and terminals -- is privately owned and operated. However, some short lines, abandoned by the major railroads, have been purchased by local government to maintain service. Since the passage of ISTEA some state and local governments have used Congestion Management Air Quality (CMAQ) funds to build intermodal rail terminals or connections. Rail track, particularly in metropolitan areas, is shared with Amtrak and/or passenger commuter rail operations.

Rail terminals historically were located in center cities. Many of these older terminals have been modernized to handle intermodal traffic, particularly from nearby seaports. Several railroads are also making major investments to build large intermodal terminals at new “greenfield” sites on the fringe of major metropolitan areas. Examples include the Santa Fe’s investment in a nearly 600 acre terminal on the outskirts of Fort Worth, and Norfolk Southern’s new 800 acre terminal west of Atlanta. Rail terminals are often managed by private contractors.

Rail equipment is entirely privately owned. Ownership can take one of several forms: by the railroad itself, by a third party lessor or pool, or by the ocean carrier using the equipment. Because no railroad has a transcontinental network, exchange of equipment (interline transfer) between railroads is common practice.

(3) Pipelines:

Since the 1860's pipelines have been used to transport fuel products, primarily petroleum and natural gas. Pipeline development and operation is almost entirely a function of the private sector. The only Federal role is regulatory to insure safe operation and rate oversight. Because pipelines, by their nature, move the product from point to point they do not usually interchange with other modes of transportation. Pipeline transportation, although important, will not be further addressed in this paper.

(4) Highway Transportation:

Building and regulating the roads for public use has traditionally been a public responsibility in the United States. The Federal government provides substantial funding for highway programs which are, for the most part, executed by the states. Funding is derived from general revenues and funds from the Highway Trust Fund (financed with gas tax revenues) or from state and local funds often derived from fuel taxes and other user fees. The Federal-Aid Highway Program was established in 1916 to provide a nation-wide system of arterial roads based on uniform standards. It allowed the commercial trucking industry to emerge as a competitor to rail for inter-city freight movement beginning in the 1920's. The National System of Interstate and Defense Highways (the Interstate System), first funded in 1956, transformed the intercity movement of freight.

Truck transportation is the most flexible mode of transportation for providing door-to-door service. It is also the most expensive mode of transportation, except for air. Truck companies and terminals are entirely privately owned. Like rail terminals, many truck terminals have moved to the periphery of the metropolitan area to take advantage of lower land costs and less congested distribution corridors. Truck companies include a wide range of size and technical sophistication. Long haul trucking companies are very different from the drayage operators who provide local pick-up and delivery.

The last two decades have seen a trend toward larger and longer trucks. Opposed by safety advocates and some railroads, these larger vehicles provide shipper efficiencies, but restrict access to older urban areas with bridge and tunnel height restrictions. Accommodating these larger trucks around urban port and rail terminals raises serious issues for road design, construction and funding.

Intermodalism was initially viewed by many truckers as a loss of business to the railroads. More recently, with the rise in gas prices and shortage of qualified long distance drivers, trucking companies have come to see intermodal partnership with the railroads as a new market opportunity. Regardless of the linehaul mode, trucks are typically used for local pick-up and delivery. Most intermodal freight is handled at some point in its journey by a truck. It is not an exaggeration to say that trucking provides the connections in the intermodal system--the glue that holds the system together.

(5) Air Transportation:

Significant volumes of freight first began to move by air in the 1960's. Larger passenger planes provided the additional cargo space in their bellies to carry significant amounts of cargo. Air freight still represents a small share of overall freight tonnage (less than 1% of domestic tonnage), but in terms of value, its position is more significant: nearly 20% of international trade--by value--moves by air. Nearly all air freight is intermodal since local pick-up and delivery is provided by trucks.

The nation's airspace is public and regulated by the Federal Aviation Administration through the Air Traffic control function, a system of radar facilities, radio-navigation systems, precision landing systems, weather information and communication links.

Major airports are typically owned by local or state governments, with capital construction funds available from the Federal Airport and Airway Trust Fund financed by a ticket tax and locally generated Passenger Facility Charges. Airports were developed primarily for passenger transportation. Cargo facilities are often developed and owned by the public authority and leased to private operators Airports which have been constructed as small-package (UPS/FedEx) express hubs are very different from traditional airports. Aircraft using the system are privately owned.

The Federal Aviation Administration (FAA) has general regulatory and safety oversight of the industry, while Customs, INS, and the Department of Agriculture all have jurisdiction at international gateways. Aviation's primary participation in intermodal freight operations is through the local delivery of high value air cargo shipments, including operations such as FedEx and UPS.

Summary

The roles of the public and private sector in the operation of the transportation system are depicted in the table below:

Public/Private Involvement by Mode in the Freight Transportation System				
Mode	**Line Haul/ Network**	**Terminals**	**Vehicles**	**Regulatory**
Marine	Federal	State/Local	Private	Federal
Railroad	Private	Private	Private	Federal
Pipeline	Private	Private	Private	Federal
Highway	Federal/State	Private	Private	Federal
Aviation	Federal	Federal/State/Local	Private	Federal

As indicated in the table above, the principal role of the Federal government in freight transportation is the funding and development of infrastructure (for some modes) and execution of regulatory, safety, and environmental oversight of the system. These activities principally reside within the Department of Transportation (and as noted above, the Customs Service, INS, and the Corps of Engineers). While it is not the focus of this paper, it is important to recognize that the Federal government is also a major freight *shipper*. Agencies such as the Post Office, the Energy Department, and particularly the Department of Defense are all major users of the nation's transportation system.

Further, from the beginning of the nation, Federal government has had an acknowledged interest in interstate commerce, supporting actions that benefit the states collectively but cannot logically be undertaken by the states separately. Historically this has included support of interstate infrastructure such as canals, railroads, and the air and interstate highway system. Beyond infrastructure, there is a national benefit in standardization of regulations and physical dimensions across state lines.

B. Intermodal Freight Transportation

The modes of transportation described on the previous pages have each developed independently, without great concern to connection between the modes. To maximize the capacity of the nation's entire transportation system it is critical to invest in the physical links to exchange cargo between the modes and to invest in technology for exchanging information intermodally.

Containerization has been a key ingredient in the development of integrated intermodal transportation service. The introduction of standardized 20 (and later 40) foot containers for the movement of freight revolutionized the movement of freight. Containerization had its beginnings with international traffic arriving and departing by ship through port gateways. For the first decade, the use of containers was limited to ocean carriage and local truck pick-up and delivery. At the same time railroads were beginning to carry substantial numbers of truck trailers on flatbed cars (TOFC). In 1979 American President Lines made a strategic decision to limit its ocean service to the Pacific. It initiated dedicated trains to transport containers from West Coast ports to Midwest and East Coast destinations to serve those important markets. This 'land bridge" movement shortened transit time from Asia to the East Coast by as much as two weeks. Control and coordination of ship and rail schedules by a single party made for smoother transfers of equipment and cargo.

Transportation deregulation in the 1980's and easing of labor restrictions allowed integration of the separate modes, resulting in optimization of transportation and logistics operations, minimizing total system costs. Specifically, rail deregulation by the Staggers Act in 1980 followed by the de-regulation of inter-modal through-rates for international cargo by the 1984 Shipping Act moved intermodalism forward, creating new opportunities for more customer-focused marketing and pricing partnerships. Stacktrains with the ability to carry containers stacked two high, were introduced in 1984, offering a smoother ride and substantial cost savings over traditional trailer and container on flatcar (TOFC and COFC) moves.

Domestic containerized service from interior U.S. points back to port centers using ocean containers began in the mid-eighties on key intermodal corridors. The initial objective was to re-position marine equipment back to port gateways. Domestic intermodalism has offered benefits to all partners in the transaction such as:

- Ocean carriers generate revenue by moving domestic cargo instead of simply repositioning empty containers;

- Railroads win back long haul business lost to trucking;

- Truck operators, facing higher fuel costs and drivers shortages, can concentrate on the more attractive short haul business;

- Intermodal Marketing Companies (IMCs) have found market opportunities in matching carrier equipment to domestic shipper needs.

While containerization offers benefits even in single mode movements, one of its major benefits is that it makes the transfer of cargo between modes -- at ports, rail yards, and truck terminals -- faster, easier, cheaper and safer. The use of the same equipment for sea, rail, and truck operations has considerable appeal for efficient operations. However practical problems exist. Standard ocean containers are 20,40 or 48 feet long. Domestic shippers have pressed for larger containers and trailers: 48 and 53 foot containers are commonly used in domestic movements. The different nature of the intermodal partnership is another important distinction between international and domestic intermodal activity - one is cooperative, the other is competitive:

- International cargo, moving to and from North America, has no choice. It must move inter-modally. To provide door-to-door transoceanic service inevitably requires the cooperative partnership of more than one mode.

- Domestic cargo, on the other hand, has a choice. A single mode move, usually by truck can often be most efficient and cost effective. It has therefore taken longer for truckers and railroads to reconsider their naturally competitive relationship and recognize that. in some instances, they will both benefit by offering shippers an intermodal service.

The need to integrate the disparate and not always cooperative modal systems has encouraged the development of a range of third party services to link the linehaul modal services into a seamless, door-to-door operation. Intermodal Marketing Companies (IMCs), for example, have emerged to augment the freight carrier's own capabilities, notifying customers of freight status and monitoring freight payments. Railroads in particular often choose to use these third-party agents as extensions of their limited sales staff.

Value-added-networks offer mechanisms for the electronic exchange and manipulation of transportation information. Other examples of third party services include management of container, chassis, and railcar pools, resulting in significant improvement in equipment utilization, Port authorities and independent terminal operators have similarly developed a range of value-added services to smooth the transition between modes.

The transportation of smaller freight packages inter-modally has been transformed by companies such as United Parcel Service (UPS) and Federal Express. Beginning in 1987 UPS offered service to every address in the United States, and currently delivers more than 11 million parcels daily. To coordinate its transportation system UPS has developed sophisticated information technology that is able to monitor the precise status and location of shipments. Using the Internet and their own computers customers are able to track the status of their shipments.

Figure 1 illustrates the relative roles of the modal transportation actors in the provision of intermodal services.

C. Profile of the Intermodal Movement of Freight and Information

The door-to-door movement of freight from the shipper to the consignee involves:

- The movement of cargo,
- The movement of vehicles, and
- The movement of information.

Figure 2 illustrates the steps involved in a typical international intermodal freight shipment.

Figure 1: AN OVERVIEW OF THE INTERNATIONAL FREIGHT TRANSPORTATION SYSTEM

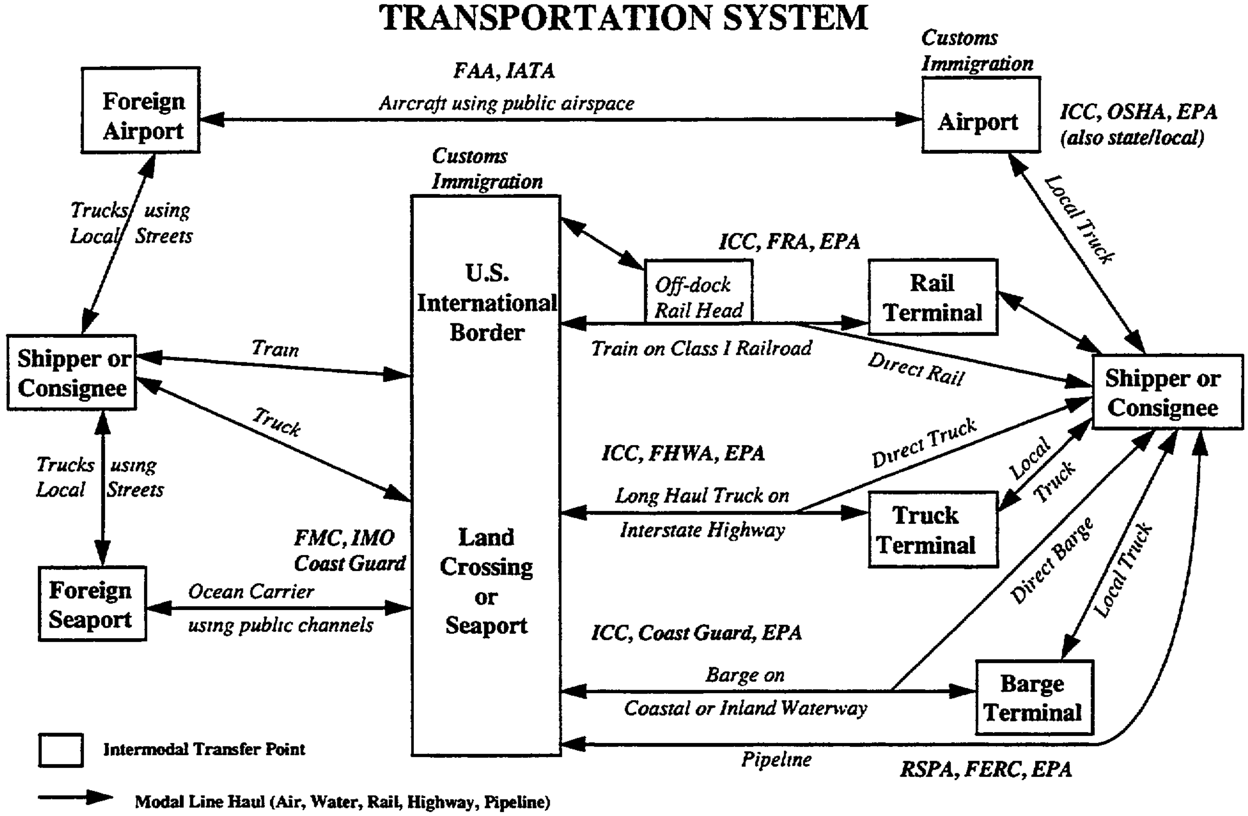
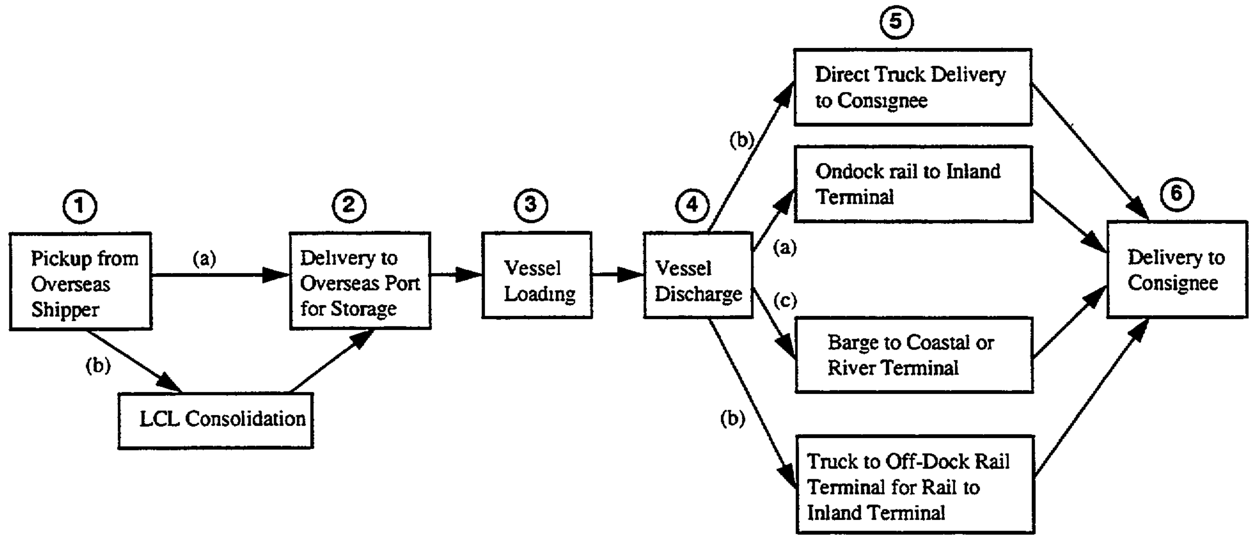


Figure 2: SEQUENCE OF AN INTERMODAL FREIGHT MOVEMENT



The domestic part of the trip would be similar to that of a domestic container or trailer. The sequence is as follows:

(1) Container Pick Up from Shipper:

a) If the freight is a full container it is picked up from the overseas shipper for direct delivery to the port by a local trucker.
b) If the freight is a less-than-container-load (LCL) shipment it is delivered to a consolidator to be grouped with other freight with the same destination and then trucked to the port.

(2) Port Storage: The container is stored with other containers for the same destination, awaiting arrival of a scheduled container ship.

(3) Vessel Loading: The container is loaded onto the vessel which sails to the United States.

(4) Vessel Discharge: At the U.S. port the container is discharged either:

a) directly onto a waiting doublestack train for rail shipment inland,
b) into the yard to await pickup by a local trucker for direct delivery to the consignee, or delivery to a nearby (off-dock) railyard for rail shipment inland, or
c) into the yard to await barge transshipment to a coastal or river terminal.

(5) Delivery to Inland Terminal: The train, barge, or long-haul truck delivers the container to the inland terminal where it is stored for pick-up by a local drayman. (In some cases the long haul truck will make direct delivery.)

(6) Delivery to the Consignee

At each of these steps when the container and its accompanying documentation change hands there is an opportunity for delay -- a ***seam*** in the inter-modal system. It is clear from studying these chains of activity that the intermodal “system” is in fact not a system at all, but a collection of systems which have been variously linked together by users. In some cases this has involved purchase of all elements of the transportation chain, allowing direct vertical integration (as in the case of Federal Express and UPS). At the other end of the spectrum are disconnected modal activities which have created a market for integrators (third party operators) to package the modal elements into a seamless system. Between the two are alliances and partnerships which effectively create specialized systems to meet shipper demands for door-to-door fast, reliable, and cost effective services.

The flow of information takes a parallel but somewhat more complex route. Information transactions might include container booking requests, Customs clearance information, fund transfer documentation, vessel stowage plans, among others. The documentation required, particularly for international freight transportation varies widely depending on the commodity, countries of origin and destination, and terms of sale.

While taking advantage of an intermodal shipment, shippers expect to deal with a single set of documentation, negotiating with a single carrier. Because each mode has its own documentation and liability requirements, facilitating the necessary documentation for an intermodal freight movement can be daunting. The services of IMCs to facilitate required linkages is invaluable to smaller shippers and transportation providers. The information flow required to support a typical international import freight shipment might include the following:

(1) U.S. importer contacts overseas shipper, opens a purchase order, and arranges a letter of credit for the foreign bank. Shipper sends an invoice and packing list.

(2) Consolidator or Shipper issues a Freight Cargo Receipt to the Ocean Carrier or Non-Vessel Owning Common Carrier (NVOCC) which issues a bill of lading to the overseas shipper.

(3) Ocean carrier or NVOCC sends the Bill of Lading to the shipper and a copy of the Bill of Lading with the invoice and packing list to the U. S. broker.

(4) The original Bill of Lading and Freight Cargo Receipt are sent to the overseas bank by the shipper.

(5) Ship transmits its Manifest to U.S. Customs electronically.

(6) Overseas bank sends a bill to the U.S. bank.

(7) A copy of the Bill of Lading, Freight Cargo Receipt are sent to the importer.

(8) Importer pays U.S. bank.

(9) US. bank sends the Bill of Lading to the broker, on behalf of the shipper.

(10) Broker arranges for a cargo release from Customs.

(11) Broker issues a delivery order to the motor carrier, authorizing freight pick-up.

(12) Overseas bank pays the shipper.

The use of advanced communications technologies to place orders, convey cargo status information, and transmit invoices and make electronic payments has dramatically changed the freight industry. Increased standardization of communication across modes will offer even greater efficiencies.

D. Trends in Intermodal Freight Transportation

Increasingly the economy of the United States depends on international trade. Over the past twenty years imports and exports have grown to the point that they now comprise twenty percent of the U.S. gross domestic product. International trade is expected to triple over the next 25 years as a result of global market trends unless transportation infrastructure is insufficient to support the market.

The shift towards greater interdependence of the world's economies has had enormous impact on the demand for transportation services. Increasingly products cannot be easily labeled "domestic" or "foreign". Production of labor intensive component parts has shifted to countries with lower cost labor markets requiring further transportation for assembly of the manufactured product. This decentralized manufacturing and assembly, involving multiple locations has increased both transportation and information management requirements. Shippers require global transportation coverage. Global markets increase the importance of international standards for transportation equipment and documentation. Over the next decade the distinction between "domestic" transportation and "international" transportation will continue to blur.

America's economy has changed in response to this globalization of commerce. This has been reflected in changes in shippers' transportation requirements. Grappling with the imperatives of international competition, shippers continue to press freight transportation providers for cost reductions and service improvements. Major shipper requirements include:

- Frequent, reliable, and fast service;
- Global service and management capacity;
- Door-to-door intermodal service;
- Dedicated (or available pooled) equipment;
- Full logistics services including tracking, warehousing, and distribution; and
- Ability to exchange information electronically to handle bookings, cargo status, billing and other commercial transactions

The transportation industry has responded to these shipper requirements by providing higher quality value-added service, often involving more than one mode of transportation. Deregulation has allowed carriers to be more responsive to customers and to develop individualized services. If United States products are to compete effectively in international markets, the nation must continue to support an efficient, cost-effective freight transportation system. In the last decade enormous savings have been achieved through deregulation and greater efficiency in the freight and logistics systems. The most important current trade and transportation trends affecting intermodal freight transportation include:

Industry *Structural Change:* Deregulation of the modal transportation sectors has permitted mergers and consolidations, creation of multimodal companies, and strategic alliances between companies. This has allowed both vertical integration through creation of multi-modal companies--ownership of the entire transportation chain by a single company, as with the acquisition by CSX railroad of an ocean carrier (SeaLand) and intermodal trucking company

(Overnight Transportation) and a barge line (American Commercial Lines) -- and horizontal integration--where companies enter into capacity agreements and market alliances to offer the full range of intermodal service, as with the agreements between railroads and major truckers such as J.B. Hunt and Schneider National.

Trend to Larger Vehicles: One outcome of the restructuring of transportation providers and their search for greater efficiencies has been the trend toward larger vehicles: larger, deeper ocean going vessels, doublestack trains, longer, heavier trucks, wide body airplanes. These larger vehicles have tended to concentrate freight activity at hubs or load centers, placing demands on the infrastructure at those hubs. In the past decade demand has grown for deeper channels, greater tunnel and bridge clearances, reconfigured intersections. Surges of cargo volume resulting from larger ships or longer trains have generated demand for larger and more efficient terminals with better access.

Shared Assets: Pooling of equipment to allow greater efficiency and utilization of assets has become increasingly common as transportation service providers in all modes seek to cut costs while improving service. Examples include vessel sharing agreements between ocean carriers, neutral chassis pools used by truckers hauling ocean containers, the neutral container pools recently introduced by the railroads among others. Shippers increasingly expect a dedicated pool of equipment sufficient to meet peak demand.

Supply Chain Integration: Traditional methods of manufacturing and distribution are being replaced by more efficient integrated manufacturing and distribution systems. Businesses have responded to competition and financial pressures by using advanced technologies to integrate shipper and carriers systems and services. Purchase orders go directly from the retail outlet to supplier's manufacturing facility. The cycle time from production to sale has been dramatically shortened, heightening the imperative for shorter, more efficient transit time to permit corporate competitive agility.

End-to-End servicer Shippers increasingly require service from door-to-door, requiring carriers to develop agreements and alliances which allow them to offer this "seamless" service. Shippers are increasingly emphasizing quality and reliability. They are no longer concerned with specific cargo routing, as long as it arrives on time, on cost, in good condition. The emphasis, driven by commercial profitability, is on end-to-end service.

Outstanding Focus on a company's "core competencies" has been another trend. Railroads for example, have decided to focus on provision of line haul services and contract out marketing and intermodal interface to third party experts. Many shippers, even major international corporations, have "outsourced" their transportation and logistics operations, contracting with experts to route their products.

Paperless Information Exchange: The need to transmit information from mode to mode creates an enormous paper flow. Paperwork has been a major obstacle to "seamless" intermodal transportation. The trend toward computerized communications will eventually result in fully integrated information systems that address operations, tracking, billing and other corporate needs. This information is not only of value to the transportation carriers, but can also update the customers on a real time basis to monitor shipment status. The explosion of access to the Internet and the World Wide Web offer nearly endless new possibilities for communication and information exchange and are transforming transportation and logistics management.

Changing Role of Government: With the passage of ISTEA in 1991 public transportation officials at all levels of government have become more aware of the role of freight transportation. Retraining staff to understand the importance of freight and the need to accommodate it within the national, regional, state and local systems has required significant cultural change within public sector transportation agencies. Private sector freight transportation providers and shippers have similarly had to learn the art of working with their local Metropolitan Planning Organization (MPO) and state officials. New partnerships and communications with the commercial sector need continuing attention.

These trends have combined in the past decade to create a challenging environment for companies providing freight transportation service. Faced with customers pressing for improved service at lower cost many companies have turned to new technologies to meet their needs. Application of advanced technology has transformed the freight transportation industry in the past decade as individual companies struggled to succeed in an increasingly competitive marketplace. These applications are discussed in the next section.

III. APPLICATION OF ADVANCED TECHNOLOGIES TO INTERMODAL FREIGHT TRANSPORTATION

Effective intermodal shipment of freight requires not only the transfer of the cargo itself but also the transfer of information between transportation modes. The container revolution and development of new information systems have been significant improvements in the past few decades. In the coming decade advanced technology is likely to improve transportation productivity with:

- New equipment and vehicle systems which increase the capacity of the modal line-haul network;
- New state-of-the art terminals using advanced technology for cargo interchange and handling to reduce transfer cost and time; and
- New information and communication technologies which offer the opportunity to generate additional system capacity through sophisticated management of existing transportation infrastructure.

This section first describes the generic technology and then explores current technology application to modal and intermodal transportation.

A. Advanced Transportation Technologies

Advanced technology, particularly information technology, has had a revolutionary impact on physical distribution of freight. It has heightened competition by providing tools for sharper, leaner, more focused operations. At the same time it has provided the tools for strategic partnerships and new supply chain relationships. Paradoxically, technology advances enhance both competition and cooperation. Generic applications which are similar across modes are described below:

(1) **Cargo and Equipment Tracking Technologies:**

Global transportation and logistics are rapidly being transformed by the ability to use communication technology to identify and monitor cargo and equipment in real-time virtually anywhere in the world. These technologies have been applied both to line haul activities and to intermodal transfer operations. The most prominent technology applications include:

Radio Frequency (RF) technology: The use of passive back scatter for automated equipment identification (AEI) relies on radio signals between passive tags and active interrogators. The technology was first marketed in the mid-l 980's and is widely used in the port and rail industries. This technology has been used extensively in warehousing and manufacturing applications and with improved reliability, durability and effectiveness it has gained acceptance at terminals to manage traffic flow through gates and to track yard equipment for improved cycle time and productivity.

Active RF consists of battery powered minicomputers that provide active monitoring of inventory and inventory state in transportation. The Department of Defense is experimenting with alternate RF technologies that use active read/write RF tags able to hold a complete container manifest. DOD is a large shipper with specialized needs to meet its requirements in combat conditions. It must be able to access information about container contents in a combat environment without certainty of access to a secure external communications network.

Cellular :Other companies, such as UPS, have chosen to install cellular phone communications systems rather than GPS to maintain direct two-way contact with their drivers allowing them to provide real-time information to their customers.

Bar Codes: One dimensional bar codes are arrays of parallel narrow rectangular bars and spaces which represent single characters in a particular symbology and are arranged in a particular order as defined in the symbology. Bar codes are printed, scanned, decoded and transferred to a host computer. The technology relieves the user of the tedious and error-prone task of reading a label and transcribing the information manually onto a form or key-entering it into a computer. Bar codes are extensively used in transportation for identifying equipment. *Two dimensional bar codes* use multiple dots or other arrays that carry larger amounts of data and can be used for personal identification (e.g. photograph) or bills of lading. Other forms of two dimensional bar codes are used by express shippers for high speed sorting of small packages.

Smart Cards are integrated circuit cards the size and shape of a credit card which contain an electronic chip allowing them to process as well as store information, currently in the 2K to 8K range. Smart cards can contain read-only memory, read/write memory, or a combination. Smart cards are increasingly used in freight transportation as part of gate transactions to identify the driver and trucking company. Other application include toll and gas payment and related transactions, and by extension, vehicle tracking.

Satellite-based Location Determination and Communication technologies are used for location determination and navigation. They provide global coverage and unprecedented accuracy. As further discussed below, applications range from aviation and maritime navigation to vehicle and cargo tracking which provides one and two way digital communications between truck dispatcher and driver. ***(a) Global Positioning Satellites (GPS)*** are a DOD owned constellation of 24 satellites which enable position determination for location and navigation with global coverage and, if Differential GPS is used, with unprecedented accuracy. ***(b) Geosynchronous Orbital*** *Satellites are* used to relay positional data on cargo or equipment movement for inventory control and security. ***(c) Low Earth Orbit Satellites (LEOs)*** promise in the near future to substantially lower cost while providing similar functions as Geosynchronous orbital satellites.

(2) Information Exchange and Communication Technologies:

In the last two decades, following the leadership of banking and financial institutions, transportation companies began to recognize that considerable savings could be realized by the electronic exchange of data. Further, as companies re-engineered their business procedures, many of those historically internal procedures were outsourced, creating a further need to exchange information and communicate electronically beyond the bounds of the individual corporation.

The interchange of information is as important to the intermodal movement of freight as the interchange of the freight itself or the equipment on which it is moving. Historically, the documentation associated with the movement of freight, particular international freight, created vast amounts of paperwork, enormous opportunities for errors in transmission and data entry and re-entry, and resulted in routine delays while cargo waited for the necessary documentation for clearance to move to the next stage of its journey. The application of advanced information and communication technologies to enhance "electronic commerce" has allowed significant improvements in the provision of efficient seamless service through use of a full including the full range of computer-to-computer links for the exchange of business information.

A specific, and particularly important, aspect of electronic commerce is Electronic Data Interchange (EDI) - the transfer of data between business partners using very specific industry standards, data sets, and protocols. In 1968 the Transportation Data Coordinating Committee (TDCC) was formed by major carriers in collaboration with shippers, financial institutions, and other partners in the shipping process, to standardize the way information about freight transactions was handled. TDCC issued the first draft transaction standards for ocean, air, rail, and truck industry documents in 1975.

In 1979 the American National Standards Institute (ANSI) accredited the Xl 2 Standards Committee to develop standard industry formats. It released the first official ED1 standard, ANSI Xl2 in 1983. International standards were introduced in 1987 when the United Nations Commission on Western Europe formally adopted ED1 for Administration, Commerce and Transport (EDIFACT) as a standard. EDIFACT's role is similar to ANSI Xl2 but with wider jurisdiction.

While EDIFACT and ANSI X 12 are not directly compatible in terms of transaction sets and software, translation software can be used to convert one protocol to the other. While carriers involved primarily in U.S. domestic trade continue to use the ANSI Xl 2 standards, those working in international commerce are moving to adopt international standards developed using EDIFACT formats. Currently documents prepared in ANSI Xl2 formats are more numerous, however this will change as international trading partnerships expand and demand grows.
The U.S. Customs Service significantly accelerated adoption of automated billing and cargo manifesting by introduction of its own automated systems. Beginning in 1984, Customs introduced an automated system for ocean (and later air) cargo. Introduction of the automated broker interface (ABI) and automated manifest system (AMS) facilitated electronic filing of the

cargo manifest, bill of lading, vessel arrival times, "in-bond" movement, status notifications, and a variety of other information of value to shippers and other participants in the system.

Customs' initial use of information technology was based on a proprietary ED1 format. However major ocean carriers insisted on the use of ANSI Xl2 transaction sets and new Xl 2 transaction sets were created for Customs applications. The US Customs Service is now supporting Xl2 on a permanent basis and also supports several EDIFACT format transactions. It is committed to supporting both standards.

The Automated Manifest System (AMS) network has been in place for more than ten years. Participants include 131 ocean carriers, 37 data processing service centers, 18 port authorities, 15 secondary notify parties, 9 software vendors, 49 direct discharge ports and 135 inland ports. Today there are more than 2000 participants in Customs' Automated Broker Interface (ABI) System. Customs automation has resulted in quicker freight release time, since electronically transmitted cargo information can be reviewed and status notifications provided up to five days in advance of cargo arrival in the United States.

The relationship between Customs and the trade community may provide lessons for the ITS program. From an inauspicious start in the 1980's when the trade community was informed that it must automate or perish, a more productive relationship has developed. Customs has become actively involved in the industry's ED1 discussions and several years ago began to attend the Xl2 meetings. In 1994 the Xl2 Transportation Sub-Committee created a Customs Task Group (I/TGB) which has actively involved U.S. and Canadian railroads and truckers. An ocean-rail sub-group has been formed to promote ED1 intermodal cooperation.

The North American Free Trade Agreement (NAFTA) has also resulted in intense interaction between government agencies and with the rail and trucking community with regard to land border crossings. The lessons learned there may translate back to the nation's ocean and air borders.

B. Modal Applications of Technology

Information and communication technologies have been in use for some time to enhance productivity in the air, marine, trucking, and rail transportation modes. Technology applications have enhanced: (a) the performance of the infrastructure, (b) the utilization of equipment, and (c) the flow of information in each mode. The experience in the major freight modes -- ocean, rail, air, and highway -- and at their terminal interfaces -- is summarized below to provide background knowledge for the discussion of the intermodal applications of technology.

(1) Marine Transportation

(a) Infrastructure: The nation's waterways and shipping channels are maintained by the U.S. Army Corps of Engineers and regulated by the U.S. Coast Guard. The Coast Guard has installed Vessel Traffic Systems (VTS) in some of the nation's busiest ports and proposes extending the program to other ports. These automated systems can both enhance safety and increase productivity. VTS, common in ports in Europe and Asia, use advanced information technology to guide vessel operations and docking and to minimize the possibility of vessel grounding. Differences in navigation, geography, tides, and weather from port to port suggest a program which creates incentives for developing unique local systems within a nationally consistent framework.

(b) ***Equipment Utilization:*** Some ocean carriers have installed fully integrated shipboard computer systems which are used for stowage planning, management of hazardous materials, equipment utilization, and communication with shore-side computers. Technology has also enhanced vessel navigation. It is not uncommon for ships and barges to be equipped with GPS technology. The International Maritime Organization is finalizing standards for the use of ECDIS (Electronic Chart Display and Information Systems) in place of paper charts. ECDIS is a combination of information streams that yield a console based real-time model of ship location, as well as the location of the bottom, dock, shore, and navigation obstacles. ECDIS is based on a digital vector-based nautical chart, which can reveal layers of information. Typically ECDIS includes a gyrocompass, a depth sounder, radar and other navigational equipment. ECDIS integrates all these tools and information streams in an on-board computer and displays the composite image on a color screen.

The Shipping Act of 1984 substantially relaxed regulation of ocean carriers operating in U.S. waters. Specifically it allowed ocean carriers to enter into partnership both with inland carriers (truck and rail companies) and with other ocean carriers. Domestically this has resulted in vertically integrated companies such as CSX and American President Companies (owners and/or operators of ocean, rail, truck, and terminal operations). Internationally it has resulted in a trend toward consortia and other vessel and equipment sharing agreements between ocean carriers.

While vessel sharing agreements and consortia result in a substantially more efficient system, they have inadvertently created temporary barriers to the implementation of advanced technology. Carriers had tagged their containers and equipment based on the internal corporate requirements of a closed transportation system. When they entered industry partnerships, sharing equipment and terminals, they returned to manual systems because their partner ocean carriers had not yet adopted compatible technology.

(c) Information Flow: Historically ocean carriers have undertaken cooperative applied research through the Cargo Handling Cooperative Program (CHCP), an industry research and technology consortium of U.S. ***flag*** ocean transportation carriers sponsored by the Maritime Administration. It has served to develop and promote innovations in maritime cargo handling such as an equipment location system, using DGPS for real time cargo location and RF readers for AEI identification of container tags; and an automated stevedore system using hand-held pen-based computers for stowage and yard storage.

In 1991, a group of major ocean carriers formed the International Shipping Agreement (ISA) to develop data sets that carriers can use for electronic exchange of data with shippers, forwarders, terminal operators, and others. The ISA published a series of implementation guides for EDI transactions with ocean carriers for booking, bill of lading instructions, arrival notices, cargo status and vessel schedules. It offers software to transportation partners and customers for an initial cost of less than $2000. The ISA experience has underlined the importance of agreeing upon industry standards since the use of ED1 requires communication of strictly standardized data -- for example a standard voyage number and a standard definition of loading and discharge port.

The ISA has had to grapple with the multiple standards currently used by their industry: in 1992 they published guidelines covering TDCC standards; a guide for application ANSI X1 2 rules was produced in 1993; and a guide for communication under international EDIFACT standards published in 1994.

(2) Rail Transportation

The freight rail industry made early use of information technology because much of its freight and equipment is transferred internally within the industry, between railroads. The need for accurate information on equipment location led to development of the Car Location Messages (CLM). In 1981, the Association of American Railroads (AAR) created RAILINC as a wholly-owned for-profit subsidiary to make the rail industry more competitive, more efficient, and a more attractive provider of transportation by creating and maintaining a centralized information service using computer and telecommunications technology and permits transmittal of bill of lading information as well as communicating other electronic business.

Railroads are increasingly making use of AEI and other rail automation systems to stay competitive. However, because railroad computer systems were installed to meet internal company and industry needs without considering the needs of their partners in intermodal transportation. Systems have developed primarily to handle internal data processing and communication with other railroads. The development of protocols which make the railroads compatible with other modes is a pressing issue for intermodal transportation. It needs to become a pressing issue for the railroads.

(a) Infrastrucrure The development of model intermodal container transfer facilities (ICTFs) which link port, rail and highway cargo transportation demonstrate the importance of handling ocean cargo, port trucking and intercontinental rail within the port area to minimize the negative environmental impact on the local residential area. Historically, intermodal rail terminals have been created by re-developing older urban rail yards. New state-of-the art on-dock rail terminals or inter-modal rail terminals being developed on the circumference of metropolitan areas minimize negative traffic impacts to their host cities.

Technologies such as Automated Train Control Systems (ATCS) or Automatic Train Supervision (ATS) technologies which are widely used on Europe and Japan's more densely used rail networks are still being explored by railroads in North America. These systems permit the same track system to handle increased operations - both freight and passenger. In partnership with Federal regulators, the industry continues to move forward with technology based infrastructure safety improvements such as real-time grade crossing warning systems.

(b) Equipment Utilization: AAR has managed an industry wide program which has resulted in tagging 97% of all cars with Amtech tags (the other 3% of cars are not in full service). There are 1500 readers distributed every 150 to 300 miles along the railbed. In this AEI system, active since 1992, scanned information from car tags is sent by each railroad to the nationwide AAR network which shippers or their tracking companies then access by computer. The tag and scanning system cost the railroads about $250 million.

Enhancements will include more seamless tracking of cars through urban rail yards from one railroad to another. It now takes up to three days to move a car ten miles across town from one railroad to another. Until recently terminal operators used exclusively manual monitoring of cargo and freight movement.

Railroads are utilizing technology to improve operation of their individual systems and to improve utilization of pooled industry equipment. Examples of improved utilization of pooled equipment are the Equipment Management Program (EMP) and North American Container System (NACS). EMP is jointly sponsored by Conrail, Norfolk Southern, and the Union Pacific which contributed 7000 new 48 foot containers to a neutral pool. Users book equipment through a computerized reservation system (REZl) managed by TIE Logistics of Newton MA.

The program began in October 1994 and since that time has improved container utilization from 2.2 to nearly 3 turns per month. The program also offers exception reports, cost allocation and control, and billing for the participating carriers. The billing program has also reaped revenue benefits for the participants: historically 50% of rail carrier bills were paid within 60 days; EMP increased billing accuracy and improved information provided to customers. It now reports 99.6% payment in under 30 days! Building on the success of EMP, the NACS program began this spring offering a similar service for other major rail carriers.

(c) Information Flow: Railroad executives agree that better management of information can improve efficiency: pre-loading and advance pickup information, advance delivery information, shipment management including early warning of late trains, efficient fleet management, better storage logistics, more efficient rail transit, and use of information systems to better deliver data to customers -- all allow improved rail system utilization. Managing operations on the street aggressively will improve terminal operations.

In 1992 the AAR and Railway Association of Canada established the Rail Customs ED1 Task Force to work with U.S. Customs to develop an automated manifest system. The Task Force developed Rail ED1 Customs Guidelines which set forth transaction sets and operational guidelines for an AMS interface with Customs in Xl2 syntax. Rail AMS came on line in September 1995 in Champlain, New York. Noyse, MN, Portal ND and International Falls MN are now on line. The Great Lakes rail gateways will be next and eventually, with participation from southern railroads, the Mexican border rail crossings.

The Rail AMS system was designed so that all the information can be directly downloaded to the recipient, saving the railroad a duplicate transmission and eliminating faxes and document handling. This means that the Customs and commercial systems can be fully integrated.

AAR reports that more than 50% of rail industry business is conducted with information originated by PC generated waybills. However since individual railroads are still heavily invested in proprietary software there is a reluctance to reinvest in an intermodal industry standard. Intermodal business is a small (and not the most profitable) segment of business for most U.S. railroads. Railroads have set priorities for their MIS staffs far more profitable than re-programming for intermodal interoperability.

Individual railroads are investing substantially in information technology. For example, in 1995 the Burlington Northern opened a new complex in Fort Worth Texas able to manage the railroad's 22,000 mile network. It provides centralized dispatching, locomotive management, crew management, maintenance of way activities, communication and signals and customer service. The system is based on real-time information about equipment location, displayed on real-time maps of the railroad's operations. At the time of its opening experts estimated that it would increase the railroad's capacity by 20%.

(3) Highway Transportation

As with other modes, information technology provides the trucking industry with the ability to improve internal efficiency and services offered to customers.

(A) Infrastructure: As observed above, the public sector is substantially involved in all aspects of highway transportation, including applications of information technology to transportation infrastructure through the ITS program. The ITS Program is evaluating several promising technologies through interstate corridor operational tests. Tests to evaluate the productivity and safety enhancement potential of these technologies are being conducted as part of the HELP program in the western states, the I-75 Advantage Program (using MACS, the Mainline Automated Clearance System) and the I-95 CVO program. These tests assume an open architecture and system inter-operability which will facilitate industry communication and global market penetration. Global standards and harmonization of U.S. domestic and international standards for marine, rail, highway and air modes are key to a seamless intermodal transportation system.

Analysis of truck freight movements recognizes that commercial flows tend to operate within interstate "trucksheds" that define the normal use pattern for freight movements within a region. Unfortunately the national transportation system does not include a unit defined as a "region" or "corridor" or "truckshed". Funds are transferred from Washington to the state highway (or transportation agency. Often, even at the state level, it is another agency which executes safety and transportation regulatory improvements. Changes need to be made in the institutional structure to encourage the regional, corridor, and "truck shed" improvements needed to facilitate freight improvements.

(b) Equipment Utilization: Long haul truckers have invested in significant technology to track their equipment and maximize its utilization. The market has utilized several types of satellites to provide locational information. A major industry leader is Qualcomm which offers a widely used two-way communication and tracking system (Omnitracs) (EutelTracs is the European version). The system provides fleet management, vehicle monitoring information, diagnostics, driver performance, dispatch instructions, and other equipment utilization information. Other vendors, including Eaton, ALK, and Rockwell, provide variations on this package.

(c) Information Flow: Information flow in the trucking industry involves fleet management, communication with customers and communication with regulating Federal and state agencies. As described above, major commercial vehicle operators have invested significantly in fleet management technologies to improve their equipment utilization. However, the trucking industry is extremely diverse including major companies which have invested in sophisticated information technology and electronic linkages with their interrnodal partners and smaller, usually local drayage, companies which have historically lagged in the use of electronic information technology. Local draymen tend to be at the end of the intermodal food chain and are at the mercy of the cost and performance demands of their inter-modal "partners".

At the Federal level, DOT's ITS Commercial Vehicle Operators (CVO) program addresses facilitation of communication between truckers and the regulating government bodies. It has undertaken major re-engineering in three regulatory categories; driver credentials, safety inspection, and electronic weigh station clearance. The program has moved from a series of operational tests to a comprehensive integration of services in a model deployment activity the Commercial Vehicle Information Systems and Networks program called CVISN. The current model deployment project is expected to be complete in 1998.

One reason for this DOT activity is that information systems supporting CVO operations have not kept pace over the years. Many of the systems supporting CVO are manual processes requiring redundant data entry which cannot share information within and among states and customers. Additionally, state safety and administrative responsibilities for commercial vehicles are projected to increase over the next several years while state budgets are anticipated to remain stable or face reductions. To address these issues, the U.S. Department of Transportation (DOT), through the Federal Highway Administration (FHWA) intends to support model deployment of CVISN in seven pilot states. CVISN is designed to link existing systems at the Federal, state, and industry level.

CVISN will utilize existing infrastructure and will enable government agencies, the motor carrier industry, and other parties engaged in CVO safety and regulation to exchange information and conduct business transactions electronically. The purpose of investing in model deployment of CVISN in pilot states is (1) to facilitate the development and deployment of ITS services that will increase the safety and productivity of CVO; and (2) to educate the general public and key state and industry decision makers on the costs and benefits of ITS for CVO.

The I-95 Corridor Coalition's Truck Desk is an example of the potential of the electronic exchange of information between the public and private sectors to enhance intermodal freight movement. Truck Desk is being developed jointly by the motor carrier industry and the states as a value-added repackager of traffic information. Truck Desk will collect information on highway traffic conditions, construction activity, traffic accidents, and incidents from state transportation agencies and other sources. It will then repackage, market, and deliver the information to motor carrier dispatchers and drivers to help them make timely and cost-effective routing and dispatching decisions. Truck Desk will build electronic links to the region's toll and transportation agencies, utilizing the I-95 Corridor Coalition's Information Exchange Network (IEN) and commercial value-added network.

(4) Air Transportation

Information technology has been key to the growth of integrated air cargo carriers and in particular to the growth of small package express services. The aggressive use of information technology throughout their operations is key to their competitive service. Sophisticated information services manage the delivery of packages by integrated carriers such as United Parcel Service and Federal Express. UPS introduced DIAD (delivery information access devices) which are hand held computers which allow information about a shipment to be input at the point of pick-up or delivery. Air cargo companies also use bar coding to track package movement and share that information with their customers.

(a) Infrastructure U.S. air space and airport approaches are controlled by sophisticated air traffic control systems based on radar and increasingly incorporate GPS and other satellite technologies. The system developed by the military is increasingly used by commercial operators for global positioning.

(b) Equipment Utilization: To date, air cargo operators are operating separate corporate systems, utilizing internal systems to maximize corporate productivity. In most cases, air cargo movements require a truck move at each end. Use of information technology for equipment control has not reached the same level of service as in other modes.

(c) Information Flow: Cargo Media, was created by the International Air Transport Association (IATA) in May 1995 to develop and promote application of information technology throughout the air cargo industry. Seventeen carriers which handle 75% of the world's scheduled air cargo are participating in the industry effort. U.S. participants include American Airlines and United Airlines. Scitor an electronic communications affiliate of IATA, enables freight forwarders and airlines to exchange messages concentrating on shipment tracking.

The growing integration of air cargo with other transportation modes is an important area to monitor. One early example of Federal, state, local, and industry partnership is the North Carolina Global TransPark Authority, a planning effort partly funded by the FAA and North Carolina. Its goal is to integrate an air cargo airport within a unique intermodal infrastructure and logistics environment, linking the Research Triangle with available regional transportation infrastructure.

C. *Intermodal Applications of Technology*

As described above, technology applications were most often initially developed to streamline the internal business processes of an individual company -- its billing system, payroll, or inventory, for example. Communications external to the company, with customers, suppliers, or regulatory agencies continued to be transacted on paper. While some effort has been made to standardize data sets and information protocols, these efforts have largely been limited to individual modes of transportation, often working through modal trade associations, sometimes in cooperation with the modal regulatory agency.

The growth of intermodal freight activity has increased pressure to improve the efficiency of the transfer of both cargo and information between modes. As discussed below, terminal operators and intermodal facilitators have become important players in improving the "seamless" transfer between modes. While creative application of advanced technology has been at the heart of their success, they have also had to grapple with the problems caused by the disparity between individual corporate systems.

(1) Terminals:

Terminals are the interface points in the intermodal system, where freight, equipment, and information are transferred from one mode to the next. Terminals include maritime ports at which freight is transferred from container ships to truck, rail and barges; rail yards where containers are transferred to and from trucks; truck terminals where vehicles are exchanged between long haul truckers and draymen for local delivery; and air cargo terminals where air freight is transferred to truck for local delivery. Terminals are often the "black-hole" in the system, where cargo can be delayed for days for lack of clearance or problems in communication between the parties.

(a) Marine (Port) Terminals: As transfer points between the land and ocean modes of transportation marine (port) terminals are, by definition, intermodal. Because most ports are publicly owned but operate to serve commercial clients, they are accustomed to the concept of public-private partnerships and have a unique perspective on intermodal freight movement and the intennodal freight community. Most ports have long standing relationships with their local and regional truckers and should be included as key players in the application of ITS to "their" CVO communities. Their experience in meeting the challenge of U.S. Customs automation may be of value to the ITS program.

Infrastructure: Historically, ports took responsibility for operation of their own port facilities. To meet current market trends, port facilities are growing bigger, cranes heavier, and channels deeper. An extraordinarily competitive market environment has led ports to focus increasingly on improvements to their access infrastructure: on the waterside the need to keep access channels dredged to depths necessary to handle the larger next generation vessels; and on the landside to build adequate highway connections to the Interstate System and to adjust railroad clearances and yards to handle doublestack railcars.

Equipment Utilization: In the past decade, ports have also worked with local terminal operators to install automated gate and terminal operating systems. The InfoTech Committee of the American Association of Port Authorities and TOPAS (Terminal Operator and Port Authority subcommittee of the Transportation Data Coordinating Committee (TDCC) have provide industry leadership in these areas. These port gate systems and their user communities offer an important opportunity for state and corridor ITS/CVO implementers. For example, SeaLand has installed a state-of-the-art Terminal Automation System at its terminals in Charleston and Port Elizabeth. The systems are based on wireless LAN, using RF, declassified military technology with a 300 yard reach. It has five components which control the gate, the yard, equipment inspection, marine operations, and yard inventory. Maher Terminals in Port Newark is an industry leader in port terminal technology applications. Port terminals have learned that they must take the responsibility for developing the interface to accept disparate data formats from their customers. They report that insisting on a standard format is useless.

Most recently, ports and terminal operators have introduced "smart cards" at terminal gates to identify truck drivers and the companies they represent. One example is the SEALINK Driver Identification System which provides registered drivers access to Port Newark and Port Elizabeth terminals. This card positively identifies the driver receiving containers.

Information Flow: During the 1980's Customs continued to change the protocols for its automated system, requiring costly and aggravating adjustments within the port, carrier, and broker communities. Currently active port systems range from the ORION system developed in 1982 in Charleston, SC which has a full community cargo system to the ACES system in New York which offers an electronic mail-box to the port community, leaving the rest to the user. South Carolina estimates that use of the ORION system results in 2 to 3 days faster cargo clearance from the port.

(b) Truck and Rail Terminals: Introduction of information technology to truck and rail terminals is constrained by the culture of those operations. The cost of buying into an intermodal electronic network can seem insurmountable to a small terminal operator, despite the almost immediate savings even the small operator might realize in increased equipment and driver utilization. Truck and particularly rail terminal operations are frequently operated by contractor or contract labor. This creates barriers of communications and information flow between the line haul and terminal operations. Since the passage of ISTEA in 1991 public transportation officials and private sector freight terminal operators have initiated a variety of efforts to improve communications. Outreach to terminal operators should be a key component of the ITS/CVO deployment, since it is at these terminals that the CVO program will interface with existing ED1 based programs already in use within the freight sector. Regular communication with companies involved in terminal operations will be of value to all parties.

(2) Third Party Companies - Facilitators:

Third Party Companies have stepped forward to create a service in intermodal transportation which serves both the shipper and the transportation provider by filling in the gaps and linking the modal systems. Intermodal facilitators include non-vessel owning common carriers (NVOCCs), shippers' councils, brokers, forwarders, inter-modal management companies, and consolidators among others. Value Added Networks, such as Kleinschmidt, transmit information between the customers and the transportation carriers' computer systems. Kleinschmidt connects with companies all over the world, collecting information for major and short line railroads and major rail shippers. Shippers use Kleinschmidt not only to check cargo location but also to produce bills of lading, advance shipment notices, purchase orders and other information forms.

Intermodal Marketing Companies fill in where other partners in the intermodal chain fall short, notifying customers of freight status and monitoring freight payment by the ultimate customer. International shipments generally are geared to coincide with a particular sailing date and shippers are able to plan accordingly. Intermodal service falls down when a drayage company isn't familiar with railroad requirements. Things get worse when a trucker lacks the ability to communicate electronically with other parties involved in the move. Whenever more than two parties are involved in the cargo move the risk of someone dropping the ball increases.

Third parties play an increasingly vital role in arranging intermodal moves, especially for small ocean carriers which prefer to limit their service to port-to-port transportation. Larger lines will continue to offer an all-inclusive intermodal service on their own bill of lading. Advanced information technolo,y can offer international market opportunities.

D. Intermodal Experiences and Technology Issues

The frequently used term "inter-modal industry" can be misleading. It suggests an organization and coherence that is notably absent in the rapidly changing intermodal freight transportation sector. In each mode, and across modes, transportation service operators have reacted differently to the new imperatives of shippers' global transportation requirements.

At one end of the spectrum are carriers that have custom built new, efficient (and usually much larger) equipment to serve modem inter-modal terminals in which they have invested and which are often managed by their own intermodal company or a contractor specialized in intermodal movements. They have considerable financial resources, have invested in multi-modal capacity, purchased their own equipment and operate worldwide computer networks to coordinate their activities. They are able to link electronically with their customers and partners to offer cargo tracking and reliability. They are industry leaders.

At the other end of the spectrum are small companies which have identified a market niche which allows them to survive in the fiercely competitive environment. They may have identified a particular geographic location, unserved by major carriers. They may be national flag carriers, or have a special relationship with a commodity shipment, or with a labor union. They are more likely to lease equipment (usually not state-of-the-art) and work through common-user terminals. They are far slower to adopt new information technologies, and do so when pressed by customers only for market survival. Between these two extremes are most transportation providers. They lack the resources of the industry leaders, but are not as niche focused as the small companies. They may be most vulnerable to technology change.

Regardless of their position on this spectrum, transportation companies have aggressively taken advantage of information and communication technologies to improve the performance of their systems. The weakness in the system continues to be at the links, the hand-off from one mode to another. A container can travel between Los Angeles and Chicago in 4.8 hours only to require an additional 40 hours for local delivery because of lack of pre-notification.

Recognizing the key role of information and communications technologies in providing a seamless and efficient intermodal freight service, a number of groups are working to address the coordination of EDI/ITS across the freight and logistics industries and to improve interoperability of the existing systems.

From the modal perspective, the American Trucking Association, American Association of Port Authorities, and Association of American Railroads have each established a committee charged with addressing ED1 efforts within the respective mode and with government regulatory agencies. The Electronic Business Processes Committee of the Intermodal Association of North America and the ANSI Xl2 Transportation subcommittee have taken on the task of facilitating communication across the modes, encouraging dialogue between the various participants in the inter-modal freight cycle.

By its very nature intermodalism requires the exchange of equipment, cargo and information. This means that the interoperability of equipment and information systems is a daily challenge:

- What happens when a western railroad hands-off a car or container to an eastern railroad in Chicago?
- How do two ocean carriers that enter into a consortium agreement to share ships and terminals address the fact that only one carrier's containers have the RF tags required by the terminal gate and yard tracking system?
- How does a port design its cargo release information system when some customers base their corporate information systems on the container number while others use the bill of lading number?
- Is there a solution for the local drayman when each terminal in the port requires him to use a different driver "smart card" as identification at the gate? Or the long haul trucker faced with different systems at each port and rail terminal where he does business and each toll facility and bridge on his route?
- Status codes used by players involved in the shipment of freight are similar but not identical -- how does the status code on a Car Locator Message (CLM) used by the

railroads translate into an ocean terminal status message? Is the cargo ready for delivery or not?

The ability to communicate electronically can connect the multiple participants in the intermodal movement and facilitate the smooth hand-off of cargo from one mode to another. Advanced communication technologies have transformed intermodal transportation in the past decade. For example, shipment information now need only be entered once, at the beginning of the transaction and from there forward simply updated as the shipment moves through the intermodal chain to its destination.

By exchanging freight information electronically, carriers and shippers are able to automate a broad range of billing, data entry, and cargo tracking functions. Automation has allowed carriers to enhance their transportation service by providing their customers and multiple trading parties with real-time information on the movement of the vehicle and the cargo.

The application of advanced information and communication technologies to the intermodal movement of freight has created significant opportunities for improved service and savings of time and money. Integration of tracking, control and communication technologies have led to the success of integrated carriers like UPS and Federal Express. The concept of integrated logistics is being widely adopted by trucking firms and other distribution service providers

Intransit Visibility***(ITV)*** throughout the journey is of increasing importance in both commercial and defense transportation. Combinations of automatic identification technologies (such as bar codes and radio frequency tags), information and telecommunication technologies have been transforming management of the intermodal freight transportation. Most major intermodal freight carriers and shippers have developed information systems utilizing some combination of the technology described above to provide real-time information regarding cargo location at all points in the intermodal transaction.

International competition is pushing industry to turn to ***electronic commerce*** to cut costs and improve service. Information technolo,y has been introduced to reduce cycle time, forward documents, manage inventory, plan schedules and purchase electronically. Basic service consists of communication and translation software to read and write messages, a mail box or computer link for transmission provided by a proprietary system or through a Value Added Network (VAN); auxiliary services such as encryption translation, and mailing or faxing of information to businesses not yet on-line. In addition, the rapid growth of Internet communications opens unexplored new opportunities.

Rail and truck operators are taking advantage of information technologies to better manage their equipment and achieve greater utilization. Technology application combined with neutral equipment pools and equipment sharing by all modes of carriers have resulted in ***improved fleet management and equipment utilization.***

Ports have achieved considerable gains in ***improved terminal gate and yard capacity*** through application of advanced information systems such as smart cards and RF readers and tags at their gates. Similar improvements are being introduced as state-of-the-art terminals are built for other modes, resulting in over-all capacity improvements for the intermodal system.

These improvements by the private sector to the intermodal freight transportation system also contribute to ***enhanced national defense.*** It is national policy to rely on U.S. carriers to move military cargo except under very unusual circumstances. Defense logistics leaders understand that they must rely upon the capabilities of the commercial transportation providers to move military cargo. Through organizations such as the National Defense Transportation Association, military and civilian transportation professionals regularly come together to ensure that the commercial inter-modal transportation system can meet the nation's defense transportation needs. A companion document "An Intermodal Tour of the DOD" provides an informal overview of DOD roles and relationships for intermodal issues and containerization. It is attached as an appendix for those interested in understanding the organization of intermodal transportation decision-making within DOD.

Information and communication technologies have enormous potential to strengthen the links between the individual transportation modes. The challenge of the next decade is to realize this potential to create a unified transportation system. Whether or not the freight sector is ready for the next generation of intermodal technology applications depends to a large extent on how these technologies are marketed, who is asked to pay for them, and how compatible they are with the advanced information systems currently in use.

E. Intermodal Opportunities

Freight transportation in major urban areas is increasingly congested. Cities which host major international sea and airport terminals experience particular congestion, both in local freight delivery by draymen and by local delivery of containers to rail terminals for shipment to inland destinations. If intermodal freight mobility is to be maintained it is essential to:

- Reduce traffic congestion in and around urban freight terminal access thoroughfares;
- Improve door-to-door visibility of intermodal freight for shippers, receivers, and transportation companies;
- Better manage the flow of truck and intermodal containers to ports and other urban terminal operations.

It is essential that national commitment to funding and constructing improved access to ports, both by land and water, be continued. In addition to these important physical improvements, ITS provides opportunities to mitigate these urban transportation problems of international gateway cities. The ITS program offers opportunities to apply concepts of dynamic flow control, as developed in the aviation and rail transportation systems, to enhance urban freight mobility. Dynamic flow control can be defined as the active, intelligent balancing of transportation and logistics demand and supply to minimize congestion and maximize capacity and flexibility. It requires: real-time (or near real-time) data on vehicle location and network conditions; powerful analytic capabilities; and the management ability to affect or control operations.

The ITS program and the I-95 Corridor Coalition project are proposing a test which will provide an opportunity to address these needs in the New York/New Jersey region at the Port Elizabeth and Port Newark terminals. The test would develop an intermodal container location system (ICLS) to better manage and track the flow of trucks and intermodal containers, to provide dynamic flow management. A description of this proposal will illustrate the opportunities which ITS offers to improving freight movement in urban areas and the opportunities for cooperation between the public and private sectors.

The volume of truck traffic at the marine intermodal terminals is large. For example, SeaLand's terminal generates over 2,000 truck moves per day or about 150 truck moves per hour. The adjacent Maher terminal, the largest public terminal at the port complex, generates over 4,000 truck moves a day, or 300 truck moves per hour. Each truck arriving at the marine terminal must stop at the entry gates for processing - matching truck and container numbers to shipping orders, identifying the driver for security, and assigning a pick-up or delivery location for the container or chassis.

The visibility of intermodal truck operations could be improved at reasonable cost by piggybacking on the dedicated short range communication (DSRC) systems being installed on the regional highway network by the public sector for toll collection and weigh station pre-clearance. These systems identify passing trucks and add location, date, and time stamps to create an observation record that could be used by terminal operators to manage inbound traffic flows, and by shippers and receivers to improve the visibility of the truck portion of inter-modal shipments, especially long-haul drayage.

The proposed ICLS would use the I-95 Corridor Coalition's Truck Desk described above as a clearinghouse to collect and screen the truck location observations. The ICLS would expand on this capability, allowing it to collect data from toll authorities and electronic clearance services for the ICLS. The ICLS operational test would seek to demonstrate the following benefits as a minimum:

- For I-95 Corridor Coalition toll authorities and state departments of transportation - the reuse and resale value of truck data from toll and weigh station transactions. This would leverage the investment made by these agencies in toll collection and ITS systems.
- For Truck Desk - a value-added information service for intermodal truck operators and public sector agencies that minimizes costs and hassles for toll agencies and carriers; better data on traffic flows for eventual reuse and possibly resale.

This operational test can become a reality as a partnership between the U. S. DOT, the I-95 Corridor Coalition, the terminal operators, trucking firms, and logistic companies. Early discussion has found interest among these entities. This is a clear example of opportunities which exist for public-private freight partnerships. It also illustrates the critical importance of inter-state regions and corridors for freight transportation.

IV. RECOMMENDATIONS FOR FEDERAL ACTION

Private freight carriers have made substantial use of information technology to enhance the productivity of their own operations. There are still areas where public investment in ITS systems can further improve the productivity and safety of intermodal freight operations. The current public interest in freight transportation policy creates an opportunity to develop a shared vision of the future needs of international inter-modal freight transportation in the United States. The Federal government can impact this vision by taking action in the following areas:

Provide Infrastructure Funding to Support Efficiency and Global Competitiveness. The private sector cannot provide seamless intermodal freight transportation services to support domestic and international trade without the underlying physical and information infrastructure provided by the Federal government. This is a crucial Federal role in transportation.

> ***Action:*** Build on the programs begun under ISTEA by providing funding for the physical infrastructure essential to the inter-modal transportation system, including terminal access roads and port navigation channels.

> ***Action:*** Provide sufficient funding to support federal programs essential to the information infrastructure including weather information, the global positioning system, navigation information, and the full communication spectrum.

Support Regional and Corridor Efforts. Intermodal freight transportation is international in scope. Supporting the seamless flow of freight is in the national interest. Many issues transcend the local or state level. It is important to sustain corridor ("truck shed") activities such as those underway in the I-75 Advantage program, the I-95 Corridor and the HELP program and to fully involve the freight community, particularly ports and terminal operators in those efforts.

> ***Action:*** Encourage, facilitate and participate in regional and corridor efforts. Establish regular funding mechanisms for these public-private alliances.

Understand the Freight Sector and Develop a Shared Vision of Technology Benefits. The complexity of the freight sector, the multitude of stakeholders involved, and their divergent priorities have created a conflicted vision of what the freight sector might gain from ITS technologies. The Federal government is positioned to provide leadership, to develop a shared vision of the capabilities of technolo,y applied to global transportation and its benefit to the nation, to the private sector and to state and local governments, and to incorporate into this vision knowledge derived by Department of Defense as a major user of the system. To effectively meet the needs of the intermodal freight transportation sector it is necessary to understand freight transportation operations and priorities, including current awareness about the state of the art applications of information technologies.

> ***Action:*** Participate actively in industry meetings, activities and working groups.

Action: Provide the Office of Intermodalism with the necessary authority and funding to serve as an effective advocate for intermodal freight issues, regardless of mode, and as a technical resource for the JPO in addressing private sector ITS issues.

Action: Work with representatives of the intermodal freight industry to create an Intermodal Freight Carrier Leadership Council to meet with the Secretary quarterly and provide input on the impact of the ITS program on the freight industry, as well as such other freight policy issues as may be of mutual interest.

Lead Transportation Technology Efforts of Federal Agencies. Federal government transportation technology initiatives are often not coordinated so that private transportation companies are required to integrate conflicting Federal initiatives. The current regulatory and reporting system for commercial transportation operators is complex and duplicative. ITS offers significant opportunities for single point electronic delivery of information to government agencies.

Action: Lead Federal transportation technology policy initiatives, particularly the work of the National Science and Technology Council's Transportation Committee.

Action: Coordinate transportation technology policy among Federal agencies, particularly border crossing initiatives.

Action: Coordinate DOT/DOD/industry efforts to adopt interoperable transportation technologies, particularly for tagging and tracking of cargo.

Action: Support CVO operational and corridor tests.

Action: Use technolo,y to simplify the current regulatory and reporting system for commercial intermodal operators by providing single point electronic delivery of information to Federal and state agencies, as conceived in the CVISN program.

Maintain Commitment to Open ITS Architecture. Participants in intermodal transportation are reluctant to absorb the cost of implementing technology if there is a fear that the technology adopted will rapidly become obsolete or incompatible. This is of particular concern in the interface between private sector and government operated systems, e.g. toll facilities and border crossings.

Action: Facilitate private sector efforts to adopt industry-wide performance standards and data protocols.

Action: Address issues of data exchange and interoperability among commercial users and Federal agencies including the Departments of Transportation and Defense and the U.S. Customs Service.

Action: Involve port and inter-modal freight terminal operators in ITS /CVISN deployment to identify opportunities and problems at the interface between ITS and the existing intermodal freight systems.

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APPENDIX: AN INTERMODAL TOUR OF THE DOD

An Intermodal Tour Of DOD

An Informal Overview Of DOD Roles And Relationships For Intermodal Issues And Containerization

July l0, 1996
Version 2

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Volpe National Transportation Systems Center
Research and Special Programs Administration
U.S. Department of Transportation

An Intermodal Tour of DOD[1]
Version 2

Purpose of this material:

This paper describes organizational roles and identifies key players in intermodalism and containerization within DOD. It is an informal resource for people in DOT, particularly the ITS community. The paper was prepared at the request of Mike Onder in the ITS Joint Program Office, FHWA. The author is Mike Wolfe at the Volpe Center.[2] Comments, clarifications, and questions are welcome.

Office of the Secretary of Defense (OSD)

This is the home of transportation policy in DOD. They publish the DOD Instruction for Intermodal and Container Policy. The orientation in OSD is more towards business practices and interfaces with industry than to military operations -- but this is a matter of emphasis, not absolutes.

Asst. Deputy Undersecretary, Logistics (Transportation)

Mary Lou McHugh, a career SES, is the incumbent (703/697-655 1). The container portfolio on her staff is generally with Army Colonel Bruce Dikeman, 697-7286). Mary Lou usually chairs the Defense Transportation Policy Council, a monthly information exchange meeting of senior players.

Joint Chiefs of Staff

Joint Staff, Director of Logistics, J4

The J4 is the focal point for logistics feasibility and supportability questions for deployed military forces. Intermodal issues, often referred to in DOD as containerization issues, are usually one of several responsibilities given to one action officer in the Strategic Mobility Division. The

1A note on phone numbers: DOD has its phone system, called Autovon or DSN. It has its own prefixes, although the last four digits usually are consistent with commercial numbers. All DOD phone numbers have commercial equivalents, which are listed here.

2 617/494-2007, fax -3013; wolfe@volpel .dot.gov.

amount of emphasis on intermodal issues varies widely depending on the priorities of the senior officers. Over the past four or five years, JCS 54 has ceded most of the leadership on intermodal issues to TRANSCOM. Major Barber is the Joint Staff representative on the Joint Intermodal Container Working Group (703/697-6155).

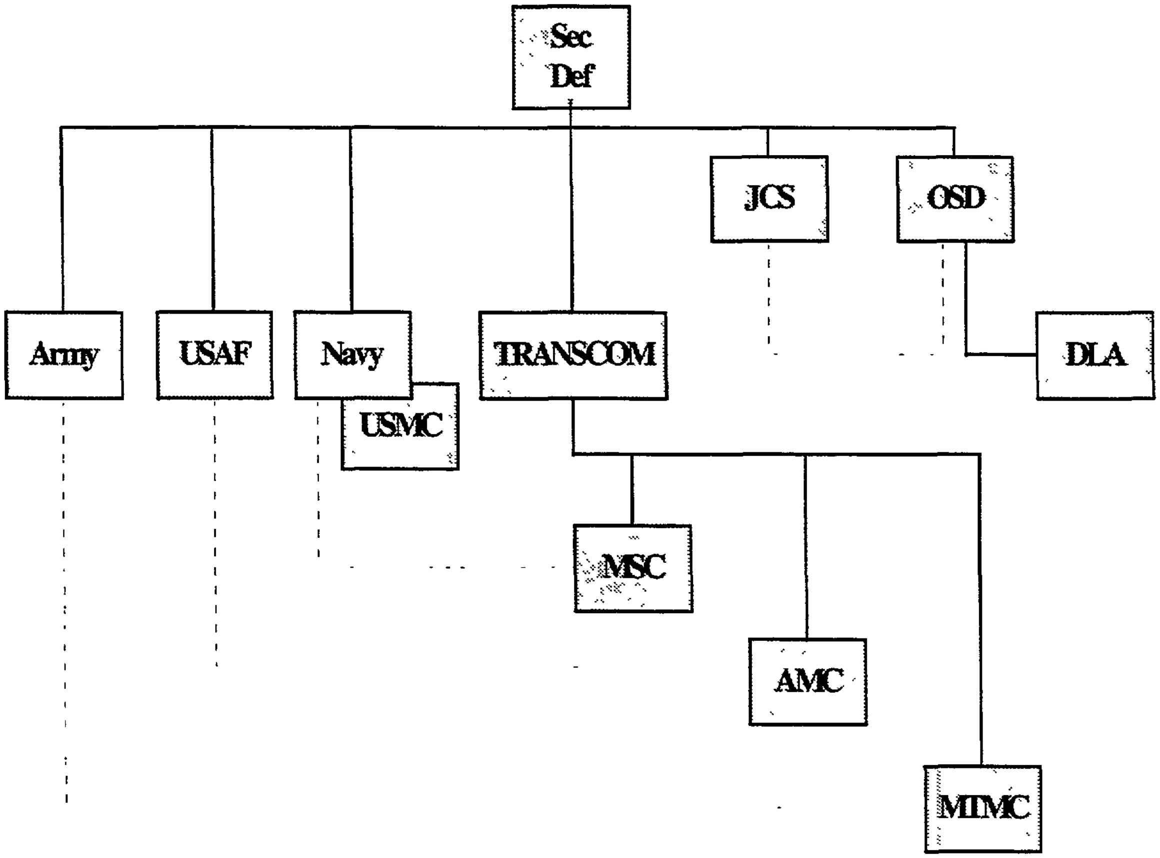
TRANSCOM Overview

The US Transportation Command was created in 1987 and re-chartered with greater scope and authority in 1992. Originally, it was responsible primarily for wartime readiness and emergency operations. After the Gulf war, it was given responsibility for managing the entire Defense Transportation System, or DTS, in peace and war. The Commander-in-Chief, or CINC, has always been an Air Force 4 star general. The Deputy or DCINC has been an Army 3 star or Navy 3 star (vice admiral).

TRANSCOM is a Unified Command under the orders of the President and the Secretary of Defense (the "National Command Authority" or NCA). In this regard it is similar to other unified "purple" commands, such as the European Command (EUCOM) or the Central Command (CENTCOM). The Chairman of the Joint Chiefs of Staff transmits the orders of the President or the Secretary to the CINCs.

On a more day-to-day basis, TRANSCOM's headquarters staff elements take external guidance from the JCS Joint Staff, which is TRANSCOM's principal point of entry into the Pentagon. The OSD staff also plays a role, setting policy for the DTS while TRANSCOM implements that policy.

DoD Transportation Relationships



TRANSCOM Headquarters

There are several groups involved in intermodal issues at TRANSCOM Hqs in the directorates of Logistics Operations (J3-J4) and in Plans (J5)

Gary Adams is the chief of the Joint Container and Plans Team, in J3/J4. Gary is the chair of the Joint Inter-modal Container Working Group, and he is concerned with operational issues, such as tagging and tracking munitions in containers. (619/256-2848). Gary's people are the coordinators of the Joint Intermodal Container Master Action Plan (JICMAP 96). CDR Brian McKeever is Gary's key guy on the working group.

Another element of J3/J4 is relevant because of a significant role in Intransit Visibility (ITV). A major set of issues in ITV has to do with electronic tagging of containers. The key player is USAF Col. Vie Wald, chief of the Transportation Management Division, (618/256-3823).

The Plans shop, J5, is more concerned with long term business relationships, such as contractual arrangements between US flag carriers and DOD. The erstwhile Intermodal Team is now the Infrastructure Team, under Dave Dias (618/256-6529).

J5 is also the home of the VISA program, the Voluntary Intermodal Sealift Agreement. The key person is Frank Webber, the SES deputy J5 (256-3499).

The Transportation Component Commands (TCCs)

TRANSCOM has three principal subordinate commands, known as the TCCs. Each existed long before TRANSCOM, an they used to be known as the Transportation Operating Agencies, or TOAs, a term still used by some people.

There are several important fault lines to understand. The relationships among the TCCs and between two of the TCCs and TRANSCOM carry a lot of baggage. For example, beginning in the '60s, MTMC and MSC had extraordinary cycles of conflict over container service management; MTMC and AMC fought long over the management of air movements; and MTMC and MSC struggled to maintain their independence within TRANSCOM.

The complexity continues today because each TCC is a major command in its parent service in addition to being a subordinate element of TRANSCOM. The Army, Navy, and Air Force have Title 10 U.S.C. responsibilities to raise, train, and equip the TCCs, and each service has control over their TCC's unique service responsibilities. The borders are sometimes blurred between unique Service responsibilities and TRANSCOM responsibilities.

Larry Korb, Assistant Secretary of Defense for Installations and Logistics in the Reagan years, put it well when he described the control of transportation resources and prerogatives as one of the most intensely emotional subjects in DOD.

Military Traffic Management Command (MTMC)

The Military Traffic Management Command, the Army TCC, is responsible for traffic management and terminal operations. MTMC is involved in domestic and export freight, personal property shipments, and some passenger group movements. MTMC has the largest operational role of any TCC in inter-modal issues. MTMC also has the Transportation Engineering Agency (TEA) as a subordinate unit. MTMC is the organizer for the CORE (Contingency Response) Program, which includes industry and DOT elements.

MTMC is commanded by a two star general. The command has inter-modal players in several parts of the organization. Joe Schuck (703/681-6042) is in the headquarters Plans shop and is the MTMC rep on the JICWG. Joe is most involved in military preparedness issues. There are many inter-modal players in the Operations Directorate; I would start with Len Priber, (681-6744), chief of the Delivery Systems Division, for a lead to the right people. There are also people in the MTMC Information Systems Directorate concerned with managing, tracking and tagging containers, and again I would recommend a gatekeeper. Ursula Loy, chief of the Integration Division (681-5702).

Transportation Engineering Agency (TEA)

TEA is in Newport News, and the Director is Tom Collinsworth, an SES (804)599-l 100). TEA gets into modeling, hardware compatibility issues, and installation outloading capabilities. Pete Lennon 804599-1635, has been the leader of their intermodal team.

Military Sealift Command (MSC)

The Military Sealift Command, commanded by a vice admiral, is the Navy component of TRANSCOM. MSC operates the "controlled fleet," a mix of government-owned and chartered vessels, most operated by contract crews, some by civil service crews. The principal focus of the controlled fleet is on roll-on/roll-off and breakbulk ships.

MSC negotiates the Container Agreements with the US flag shipping operators. Doug Anderson is the key person on setting up container agreement contracts. A phone number to get his phone number is 202/685-5001.

The VISA pro, – is managed at TRANSCOM headquarters, not MSC.

Air Mobility Command (AMC)

The Air Mobility Command is the Air Force component of TRANSCOM. AMC operates the transport and air tanker fleet, manages the Civil Reserve Air fleet, and charters most group movement and special mission commercial airlift. AMC is commanded by CINC TRANS as a dual hat assignment. Day-to-day leadership is provided by an Air Force three star vice commander.

AMC is not a major player in ISO standard intermodal freight issues. It has a specialized interest in intermodalism, as it relates to air transportation. This includes modular cargo handling systems plus the issues raised by the occasional need to move ISO seavans by air.

Army

Deputy Chief of Staff, Logistics (Transportation, Energy & Troop Support -- TRETS)

The Army is very dependent on containerization, aware of it, and has many players active in different inter-modal issues. Their participation list is much more complex than the other services.

The focal point for Army intermodal policy is in TRETS. The principal action officer is Norma Coffey (703/614-4059). She is their rep on the JICWG.

Army Materiel Command

Industrial Operations Command (IOC)

IOC's major role is as the commodity (inventory) manager for munitions. They are involved in a proof of principal for tagging and tracking containerized munitions. Dan Stackwick is chief of the Transportation Division, 309/782-5579.

Ammunition Logistics Activity (AMMOLOG)

AMMOLOG is the catalyst and facilitator for improving ammunition logistics. Doug Chesnulovitch is the key person on containerization. 201/724-4737. Jim Fedewitz is the key guy on tagging technologies (same number).

Combined Arms Support Command (CASCOM)

CASCOM is the logistics doctrine developer for the Army. The Army Transportation School at Ft. Eustis, VA, is part of CASCOM. CASCOM is most interested in how systems work in the field (as in with deployed military units). Capt. Carey Gipson is their JICWG point of contact (804/734-0352).

Air Force

The focal point here is at Air Force Hqs -- the Air Staff. LtCol. Rich Model1 is their main action officer (703/697-3371).

Navy

The Navy seems to view itself as a self-contained transportation carrier/operator, and in my experience the Navy has been the least active military service in commercial intermodal container concerns. Their Hqs POC for the JICWG is Steve Donahue (703/614-7384).

Marines

Although the Marine Corps is an element of the Navy Department, the Marines are independent contributors to the intermodal dialogue. The Marines seem more sensitive to intermodal issues than the Navy since the Marines must be able to resupply deployed forces on the ground. The intermodal focal point at Marine Corps headquarters is Major Jim Scruggs (703/696-1090).

Defense Logistics Agency (DLA)

The DLA is probably the largest shipper of containerized goods in DOD. Shipments originate both at Defense Depots and directly from vendors of many different commodities. More than TRANSCOM or the military services, DLA's intermodal concerns are closer to those of a large commercial shipper. The DLA JICWG contact is Fred Crawmer, (703/767-3621).

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