Overview of the U.S. Freight Transportation System

This report was prepared by the Center for Intermodal Freight Transportation Studies, The University of Memphis submitted to the U.S. Department of Transportation, Research and Innovative Technologies Administration.

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National Intermodal Transportation System Improvement Plan (NITSIP)

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National Intermodal Transportation System Improvement Plan (NITSIP)

Baseline of U.S. Freight Activities

Introduction

Our nation's economic strength and competitiveness depends on a safe, efficient, sustainable and secure freight transportation system. Whether it is moving coal from the Powder River Basin in Wyoming to Atlanta, GA or tennis shoes from China to Rochester, New York, the system must provide for the reliable, flexible and economic movement of goods – bulk and consumer – from a diverse array of sources.

The nation's freight system is a partnership between the public and private sectors, with each providing substantial parts of the physical infrastructure for those movements. The system consists of a number of modes – highway, rail, water, air and pipelines. Goods are transported either by a single mode or a combination of modes. It is the composite of all the modes and efficient connections between them that is critical for sustaining a vibrant economy.

In 2002, over 18 billion tons of commodities worth over $13 trillion were transported in the United States. This works out to 325 pounds of freight moved daily for every citizen of the United States.[1]

Figure 1 illustrates the relative modal value and volume shares in 2002. 83.9% of the value and 95% of the volume of today's freight shipments move from origin to destination via a single mode of transportation. Of these single-mode shipments, trucking transports a large percentage of volume (60.1%) and value (69.5%). Multiple mode shipments account for nearly 1.2% of volume, but 8.6% of total freight value. This is due largely to the inclusion of parcel shipments (including USPS and courier) in the statistics.

[1] FHWA. "Freight Facts and Figures, 2006." Table 2-2, Shipments by Mode and Value: 2002 and 2035.

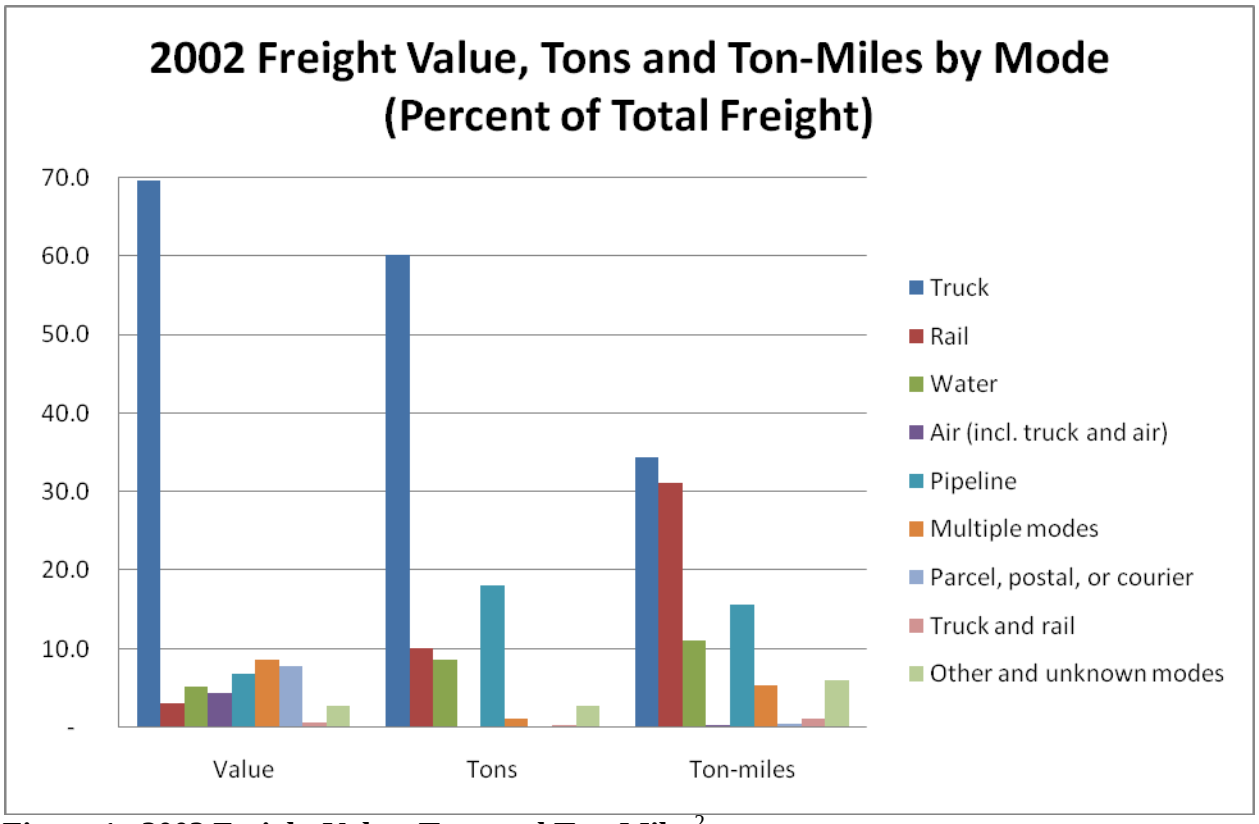


Figure 1. 2002 Freight Value, Tons and Ton-Miles[2]

Looking at the other modes, rail, water and pipeline are particularly well adapted to hauling heavy, low value goods long distances. By volume, they account for 10.2% (rail), 8.6% (water), and 18.1% (pipeline). By value, their shares are 3.0% (rail), 5.2% (water), and 6.9% (pipeline).

Conversely, air shipments, typically light weight, are usually goods of considerable value. They account for less than 1 percent of freight tonnage and slightly more than 10 of total freight value.

Nearly all products that consumers use in the United States are transported via truck at some point in the transportation journey. For this reason, trucking truly forms the "skeleton" of the intermodal transportation network.

Key to keeping this interconnected network of modes in balance is capacity for growth and reliability of service. Growing congestion on U.S. highways is a well-documented problem. Even though trucks contribute just 8% of highway vehicle miles traveled, the mode is affected by decreases in travel time reliability.

In addition to serving the population and economy by moving goods, freight transportation adds to the national economy by providing jobs for millions of people. The number of jobs in the freight industry is shown by category and mode in Figure 2.

[2] USDOT. Research and Innovative Technology Administration (RITA), Bureau of Transportation Statistics (BTS). "Freight in America: A New National Picture." Table 1.

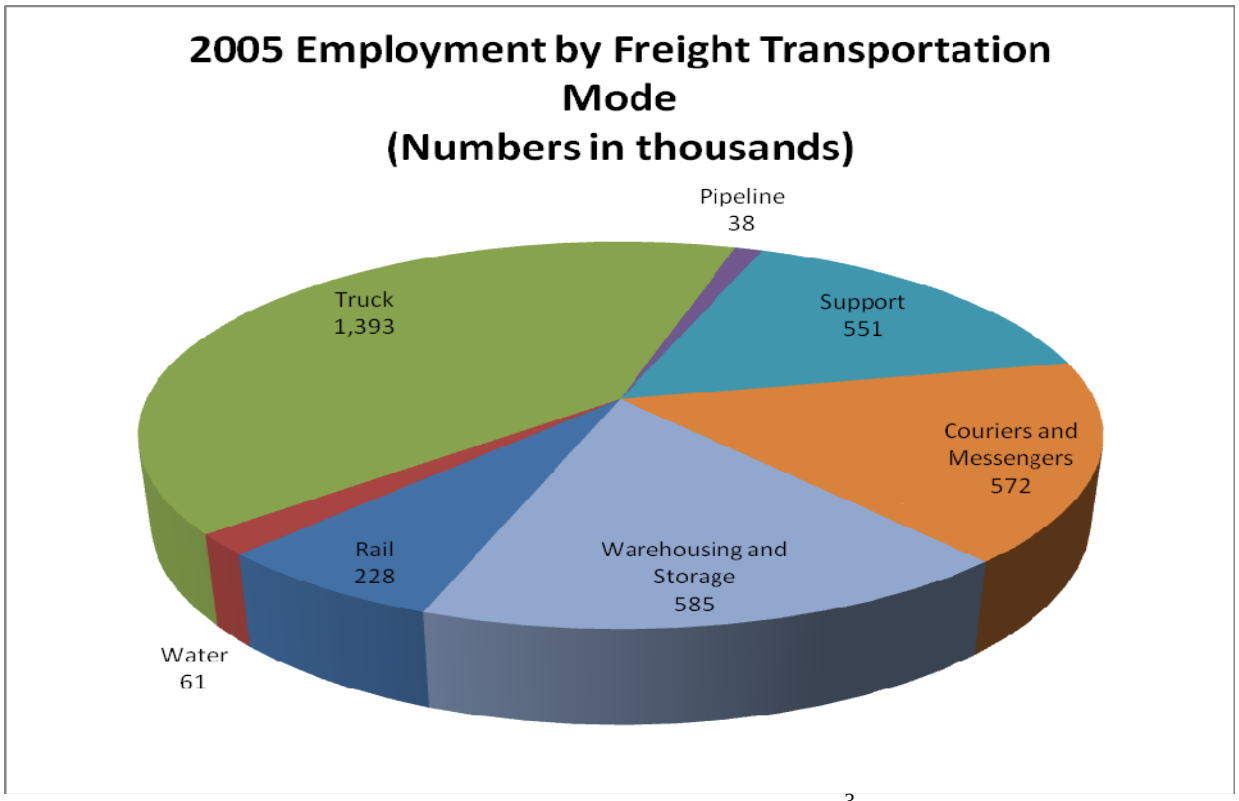


Figure 2. 2005 Employment by Freight Transportation Mode[3]

In terms of economic impact, freight transportation is an important part of logistics costs. The trends in logistics expenditure for business are shown in Figure 3. Figure 3 shows logistics costs as a percentage of Gross Domestic Product (GDP) have been going down for the past 40 years, and that until the mid 1980's transportation costs accounted for about half of the logistics costs. The economic regulatory reforms of this decade gave rise to the production innovations of just-in-time-deliveries. Just-in-time production and delivery requirements places ever greater demands on the nation's transportation system for predictable travel times for freight shipments.

Similarly the costs of inventory paralleled the transportation costs but were a little less. At this time, changes in logistics began to restructure costs distribution. Total logistics costs continued to decline, as did the cost of inventory while the cost of transportation remained constant. This is because more and more reliance is being placed on maintaining inventory in the transportation supply chain.

[3] U.S. Department of Labor, Bureau of Labor Statistics, Current Employment Statistics survey, available at www.bls.gov as of May 3, 2006

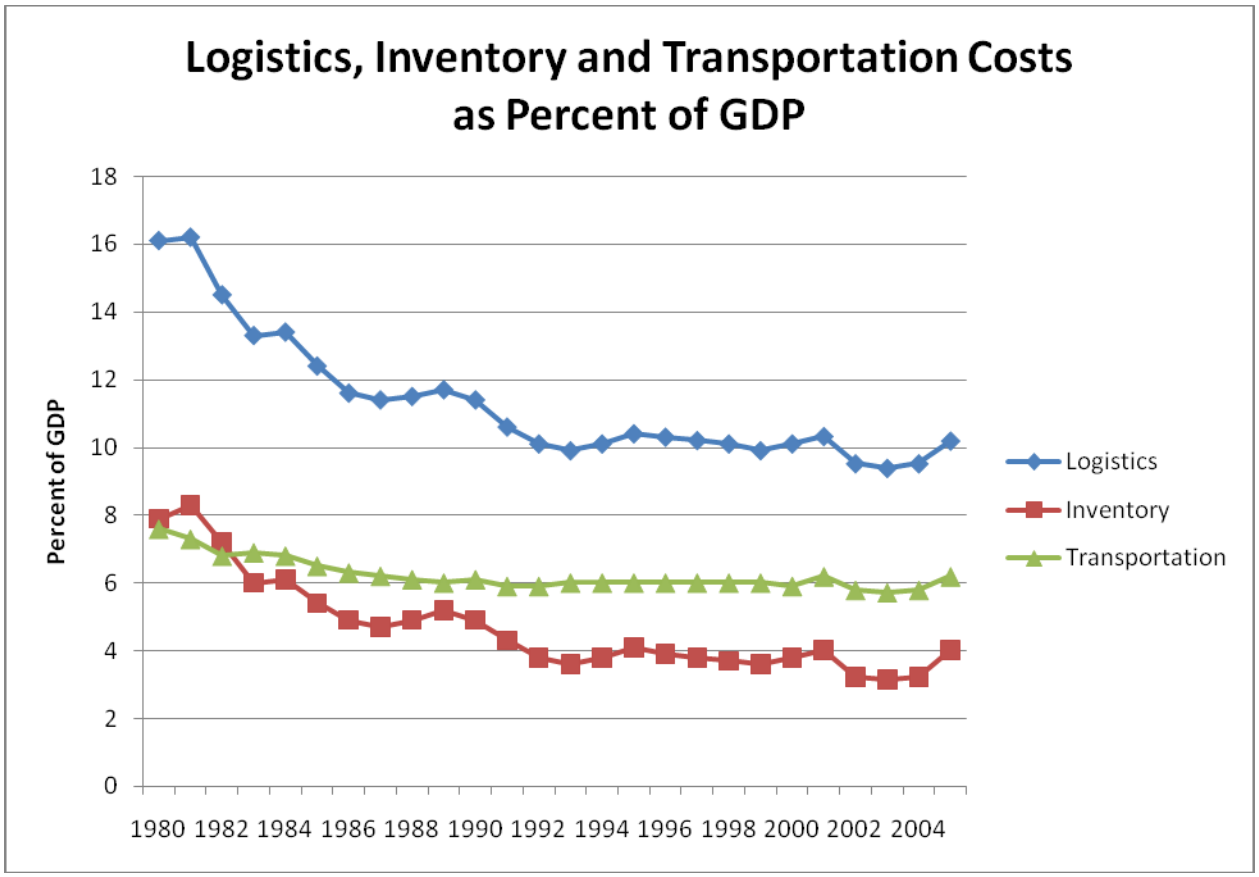


Figure 3. Business Logistics, Inventory, and Transportation Expenditures as a Percent of U.S. Gross Domestic Product (GDP)[4]

In looking at these percentages, it is good to keep in mind what Gross Domestic Product (GDP) means and how it has grown, and is expected to grow. GDP is the measure of total market value of all the final goods and services produced by the U.S. in a given year. The GDP in 1984 was $5.8 trillion for a population of about 200 million. In 2004, just 20 years later, GDP measured more than $10.7 trillion for a population of nearly 300 million. This near doubling of GDP was accompanied by a U.S. population growth of only 30% with a 300% growth in foreign trade by value. Figure 4 illustrates this dramatic growth in GDP per capita, while Figure 5 shows the growth in international trade. Understanding trends in GDP is important as commercial freight transportation activity has followed the growth and spread of population as well as heightened interdependence of global economies.

[4] FHWA. "The Freight Story: A National Perspective on Enhancing Freight Transportation." Data source: Council of Supply Chain Management Professionals (CSCMP), "17th Annual State of Logistics Annual Report.

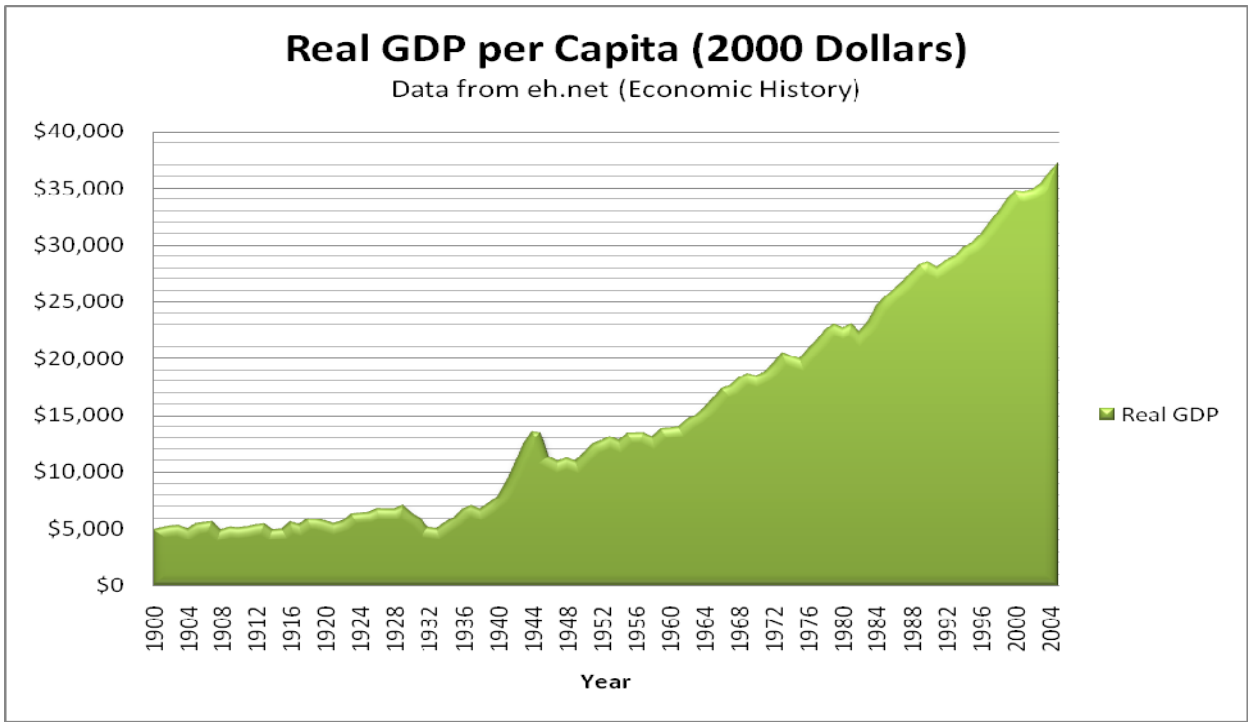


Figure 4. Real U.S. Gross Domestic Product (GDP) Per Capita5

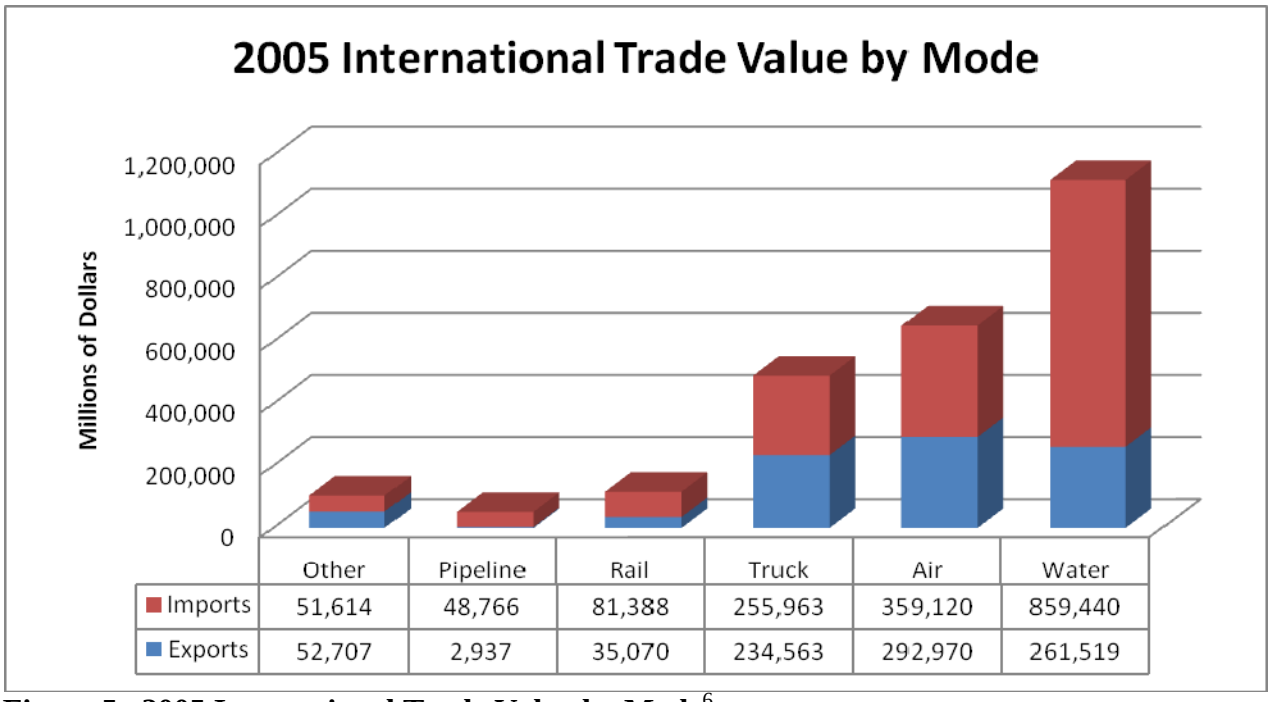


Figure 5. 2005 International Trade Value by Mode[6]

[5] Economic History Services website. http://eh.net/hmit/gdp/ BTS says give date snapshot taken
[6] USDOT, FHWA, Office of Freight Management and Operations. "Freight Facts and Figures." Figure 2-6.

Intermodal Network Overview

Each day the nation's commercial carriers deliver 30 million tons of freight using one or more modes of transportation.[7] Each mode is a network of infrastructure that is leveraged to provide the goods we expect to find in our everyday lives – whether it is clothing at our favorite retail store or home heating oil. The modes depend on each other to a great extent. For example, all air freight shipments are intermodal as they arrive at and leave the airport by truck. Nearly all international shipments are intermodal since they arrive in the U.S. by truck or rail.

The following table shows the nation's transportation system and the system's key commercial components.

Table 1. Transportation System Highlights[8]

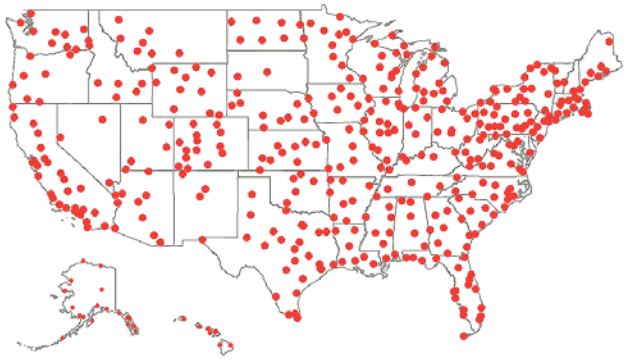
The Nation's Transportation System	The Commercial Transportation System
▪ More than 4 million miles of roads ▪ Over 160,000 miles of rail ▪ Nearly 600,000 bridges ▪ Over 9,000 waterway facilities and 26,000 miles of navigable waterway ▪ Over 5,000 public use airports and 700 million enplaned passengers	▪ 162,373 miles of the National Highway System (carry 75% of commercial truck traffic) ▪ 95,664 miles of Class I track ▪ Top 50 ports handle 89.3% of the nation's waterborne tonnage ▪ Nearly 1.6 million miles of gas and oil pipelines ▪ 129 hub airports emplaning 678 million passengers annually

[7] USDOT, RITA, BTS, U.S. Department of Commerce, Census Bureau. "North American Transportation Statistics Database" http://nats.sct.gob.mx/

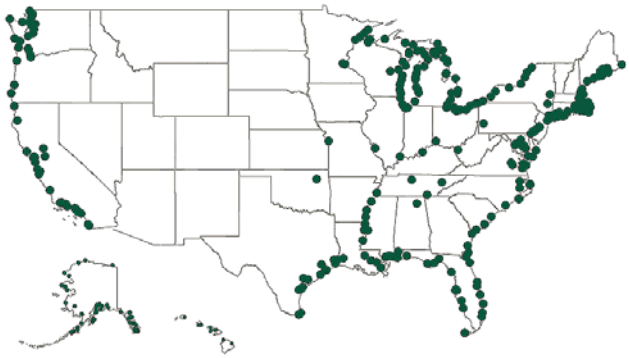
[8] BTS Pocket Guide to Transportation, 2007. http://www.bts.gov/publications/pocket_guide_to_transportation/2007

The National Highway Planning Network. It does not show all urban and rural roads in the United States.

The rail lines of Class I railroads, which are the largest railroads, as defined by operating revenue. Class I railroads represent the majority of rail freight activity.



The location of all 433 airports with Federal Security.



The location of all 353 U.S. ports.

The location of pipelines that are at least 12 inches in diameter, which accounts for the majority of all pipeline capacity.

Note: Facilities for Puerto Rico, the Virgin Islands, the American Samoa, and the Mariana Islands are not shown

Figure 6. Extensiveness of the Different Modes of Transportation

Over the past two decades, the federal government has played a pivotal role in supporting the development of the transportation infrastructure over which freight carriers operate. As shown in Table 2, since the enactment of ISTEA, federal investment, especially road investment continues to grow:

Table 2. U.S. Government Expenditures for Transportation by Mode[9]
(Current value, in millions of U.S. Dollars)

	1990	1995	2000
Total	100,684	130,540	167,351
Air	12,568	16,894	22,017
Water transport	5,480	6,628	7,946
Pipeline, oil and gas	26	45	27
Rail	540	1,043	767
Transit Rail	19,251	26,161	32,384
Road	62,629	79,375	103,952

Intermodal freight operations have their roots in the 1980s. The economic regulatory reforms in truck, rail and maritime liner industries made it possible for carriers to experiment with service arrangements. The Japanese "kaban" approach to inventory gave birth to the U.S. innovations of "just-in-time" production and the logistics industry where information about the shipment is just as important as the location of the goods. The rail/maritime liner carrier partnership that introduced the use of double stack service resulted in was the private sector's decision to use containers as the package of choice for the movement of consumer/retail goods.

Today, intermodalism is defined as "…the concept of transporting freight in such a way that all parts of the transportation process, including information exchange, are efficiently coordinated, offering flexibility."[10]

Containers moving between ships, truck trailers and trains, comprises the largest majority of intermodal movements. These containers come in five standard dimensions: 20ft and 40ft for international moves and 45 ft, 48 ft and 53 ft for domestic hauls. The capacity of maritime liner ships is measured in terms of the number container they can haul – "twenty foot equivalent units" (TEU) or "forty-foot equivalents (FEUs). The growth of containerized movements in the United States from 1980 through 2005 is illustrated in Figure 7.

[9] USDOT, RITA, BTS, U.S. Department of Commerce, Census Bureau. "North American Transportation Statistics Database." http://nats.sct.gob.mx . .
[10] Muller, Gerhardt. "Intermodal Freight Transportation." Intermodal Association of North America and the Eno Transportation Foundation. 3rd Edition. Lansdowne, VA. 1995.

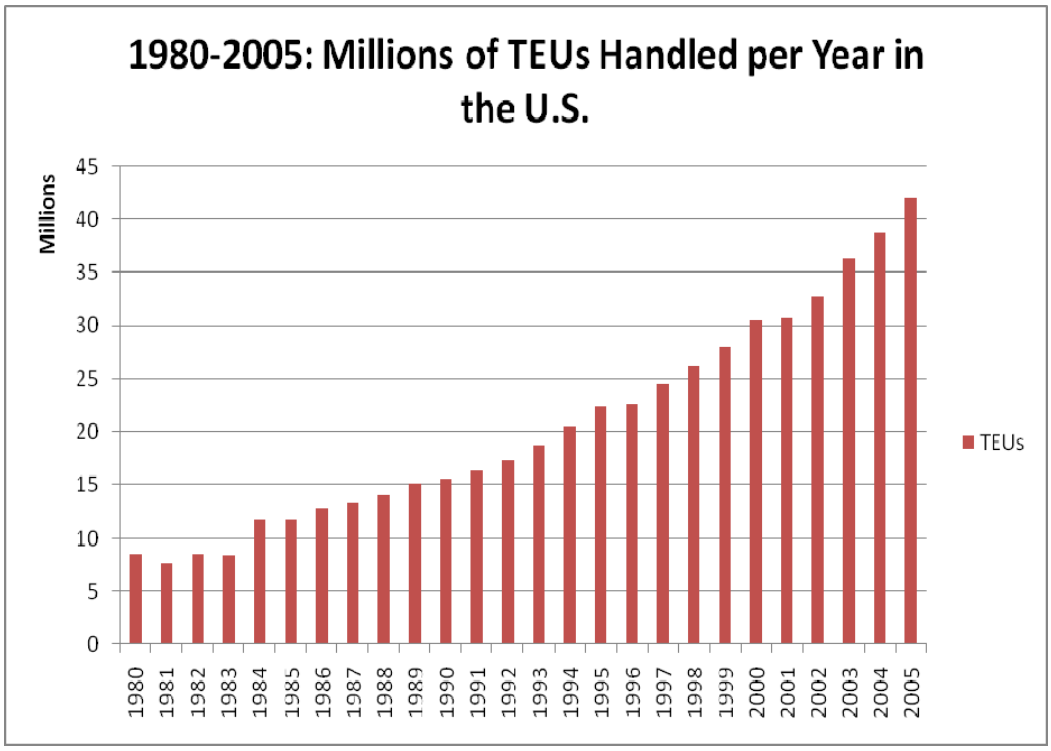


Figure 7. Twenty foot equivalent container units handled in the U.S. 1980-2005[11]

Most of these intermodal shipments are international and arrive via containership. The container is offloaded at the port. Goods are either put onto a truck chassis beneath the crane, then stored in the yard before being moved out of the terminal, either by rail or truck, or they are loaded directly loaded onto a rail car. Figure 8 shows a container terminal in the Port of Seattle.

[11] American Association of Port Authorities. Port Industry Statistics. http://www.aapa-ports.org/Industry/content.cfm?ItemNumber=900

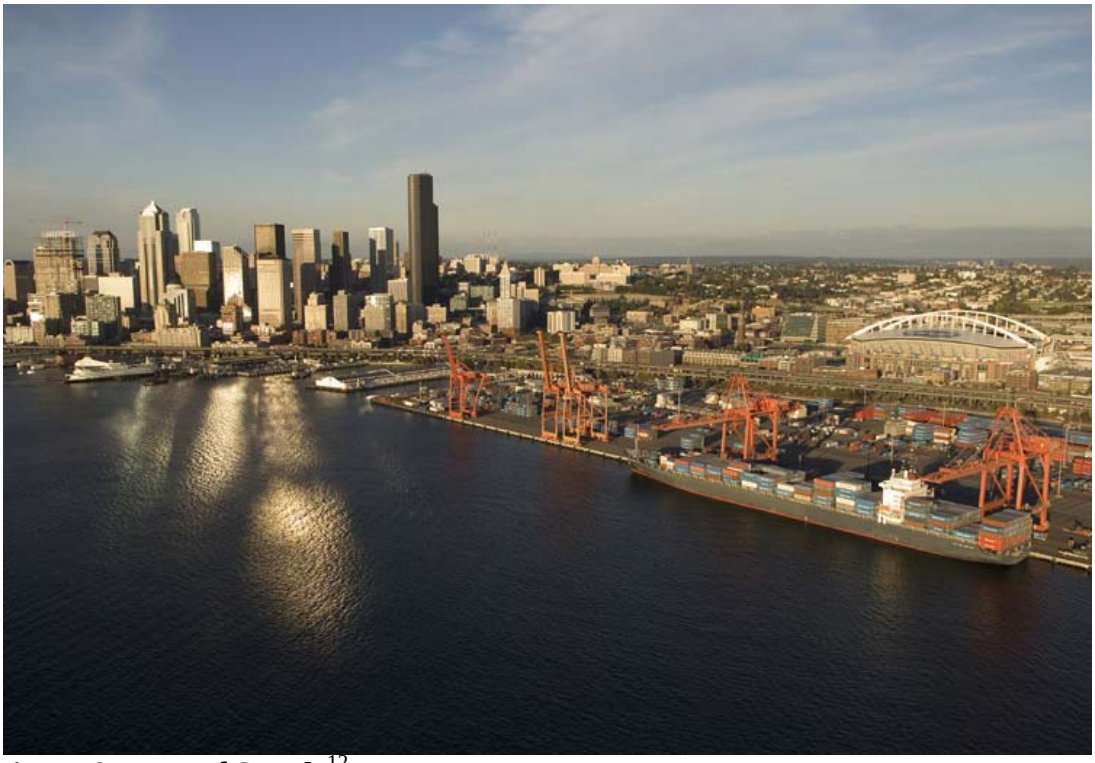


Figure 8. Port of Seattle[12]

Two advancements that may increase the efficiency of the intermodal transportation system are container-on-barge (COB) and "America's Marine Highway." COB movements enable containers to be transported on the inland waterway system via towboats and specially fitted deck barges that stack containers similar to containerships. These movements have traditionally been completed by truck, thus COB has potential to shift the containers to underutilized waterways, alleviating traffic on congested highways. Similarly, "America's Marine Highway," (formerly named "Short Sea Shipping") refers to commercial waterborne transportation that does not transit an ocean.[13] These services are intended to move traditional truck traffic away from heavily congested coastal corridors to increase mobility, reliability and reduce pollution.

Each of the nation's freight systems – rail, truck, water and air – plays an important role in creating freight intermodalism. Understanding their specific contributions creates the building blocks for future system improvements.

Highway Freight (Truck)

The motor carrier industry is the dominant domestic freight mode, with more shipments (volume and value) than any other mode of transportation. There are an estimated 1 million companies operating nearly 8 million large trucks with many more companies operating smaller trucks in

[12] American Association of Port Authorities, Port of Seattle (Don Wilson). http://aapa.files.cms-plus.com/images/img48.jpg

[13] MARAD, "America's Marine Highway Initiative." http://www.marad.dot.gov/Programs/America's%20Marine%20Highways/Marine%20highways.html

interstate and intrastate commerce in the U.S.[14] A large majority (82%) of these companies operate small fleets of fewer than 6 trucks.[15] The commodities transported by truck are varied (Figure 9). Note that 32% of these commodities fell into the "Other" category. These commodities include coal, petroleum, agricultural, furniture, electronics, etc.

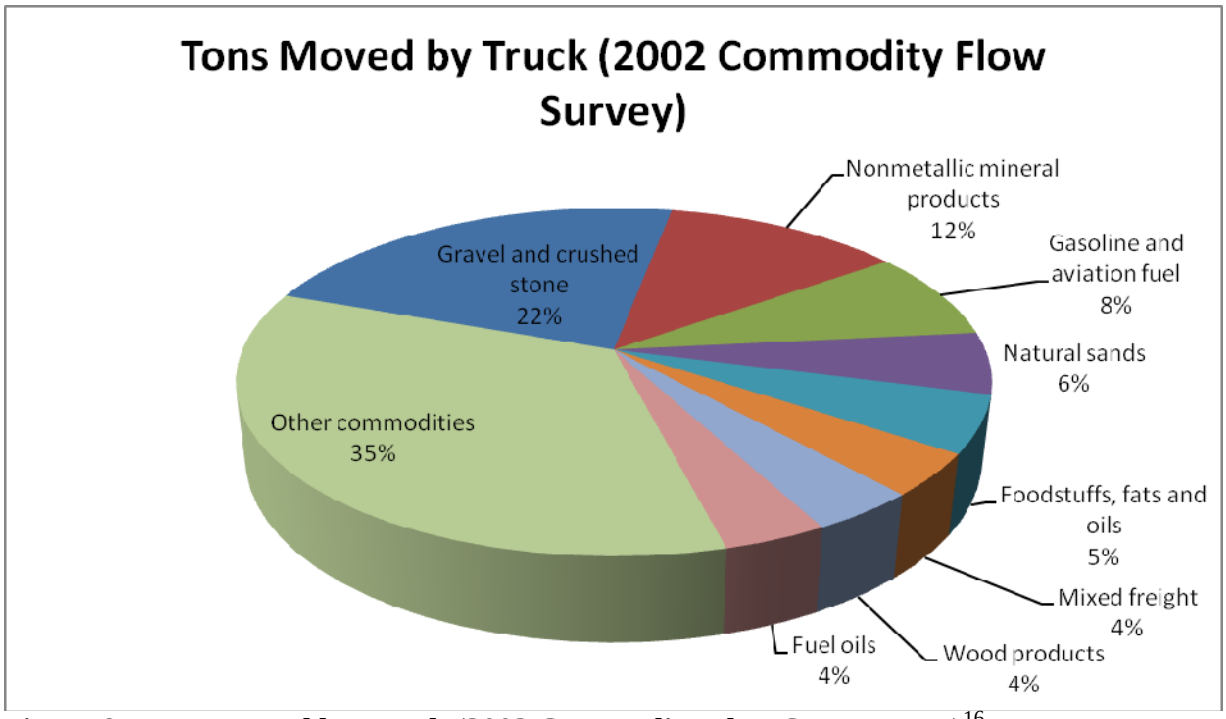


Figure 9. Tons Moved by Truck (2002 Commodity Flow Survey Data)[16]

Even though trucks account for 8% of all highway vehicle miles traveled (VMT), U.S. highways are the mode of transportation that operates most closely to its capacity. The trucking industry's travel time reliability will likely suffer if congestion continues to grow at its current pace.

The trucking industry has participated in several innovative technology partnerships with government, including weigh-in-motion technology and electronic clearance systems that enable trucks to bypass traditional state border inspection stations. One such system is PrePass, an automated vehicle identification system enabling transponder-equipped trucks (more than 400,000 as of April 2007) to bypass designated weigh stations, port-of-entry facilities and agricultural interdiction facilities.[17] The system makes use of weigh-in-motion scales and in-cab notification of whether the truck is cleared to bypass the upcoming station.

[14] http://www.fmcsa.dot.gov/facts-research/facts-figures/analysis-statistics/cmvfacts.htm
[15] http://www.truckinfo.net/trucking/stats.htm
[16] BTS, Commodity Flow Survey. Table 7, "Shipment Characteristics by Two-Digit Commodity and Mode of Transportation for the United States: 2002.
[17] PrePass website. http://prepass.com/whatsprepass.htm

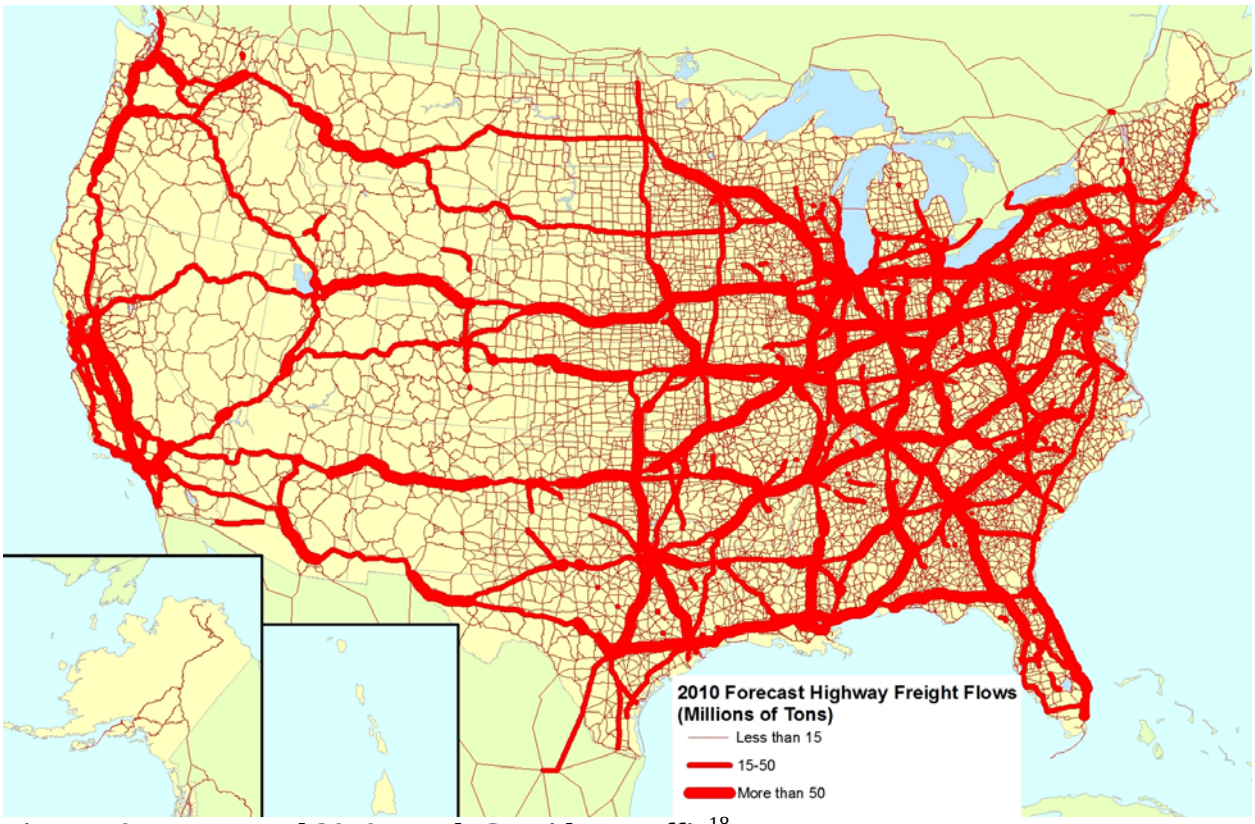


Figure 10. Forecasted 2010 Truck Corridor Traffic[18]

Rail Freight

Railroad freight is unique in that it is the only mode of transportation where the carriers own the right-of-way. Class I railroads are companies that have annual operating revenues in excess of $319.3 million. There are currently 7 U.S. Class I railroad companies that operate more than 95,000 miles of railroad in the U.S. (Figure 11). There are more than 600 railroad companies operating in Canada, Mexico and the U.S., on more than 173,000 miles of track and earning $42 billion in annual revenues.[19]

[18] USDOT. GeoFreight Intermodal Freight Display Tool, 2001. (http://www.fhwa.dot.gov/freightplanning/geofreight.htm)
[19] Association of American Railroads (AAR) website: "RR Industry Info." http://www.aar.org/AboutTheIndustry/AboutTheIndustry.asp

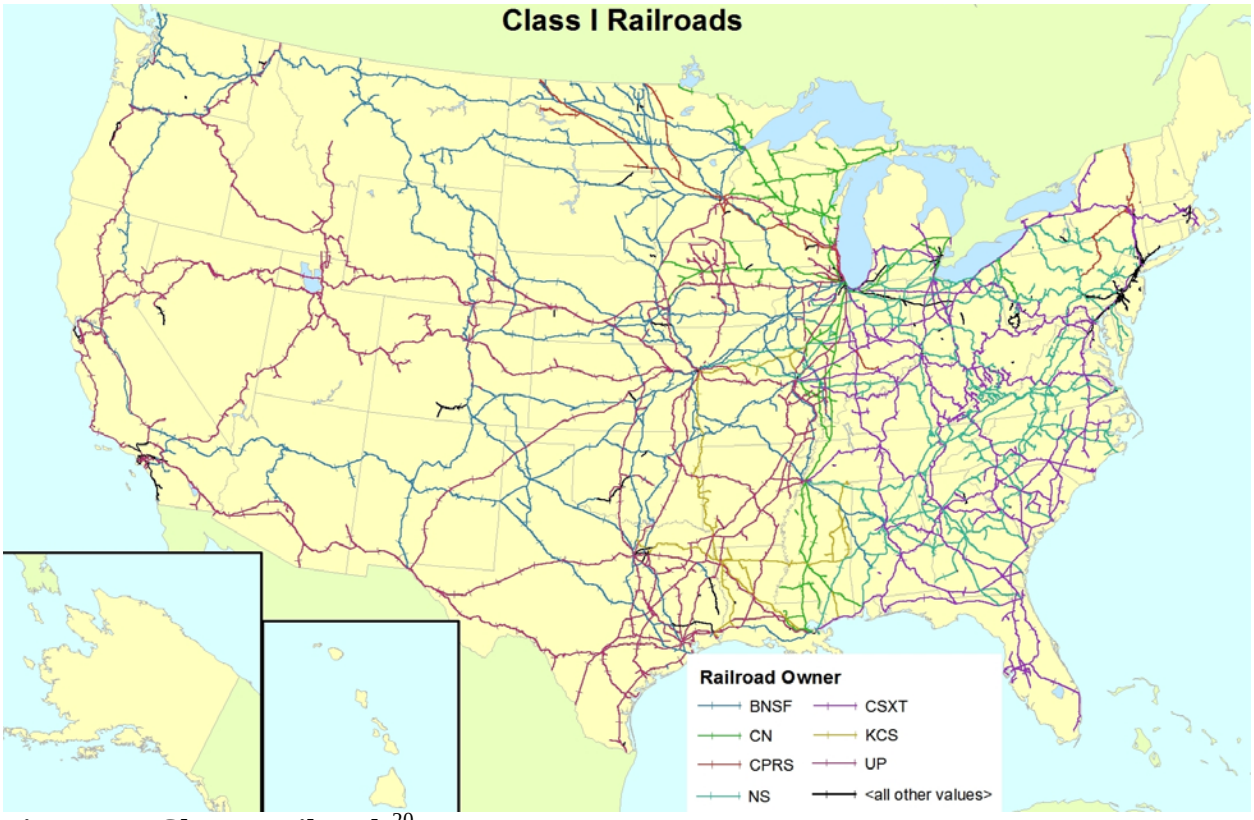


Figure 11. Class I Railroads[20]

Traditionally, coal has been the most common distinct commodity group transported by rail (by value, as shown in Figure 12). In 2005 coal made up 42% of Class I rail tonnage and 20% of Class I rail revenue. Intermodal rail shipments usually involve rail to truck transfers for the first and the final (destination) legs of the shipment. Intermodal has been the fastest growing market of rail transportation, making up 23% of Class I rail revenues in 2005 (having surpassed coal for the first time in 2003).[21] In 2003, intermodal container movements first surpassed coal shipments as the industry's largest revenue segment. This has remained the case since. In Figures 12 and 13, it is important to note that intermodal shipments are disbursed in each of the commodity groups.

[20] 2006 BTS National Transportation Atlas Database, Rail Network (1:2,000,000 base scale)
[21] AAR: Overview of US Freight Railroads.
http://www.aar.org/PubCommon/Documents/AboutTheIndustry/Overview.pdf

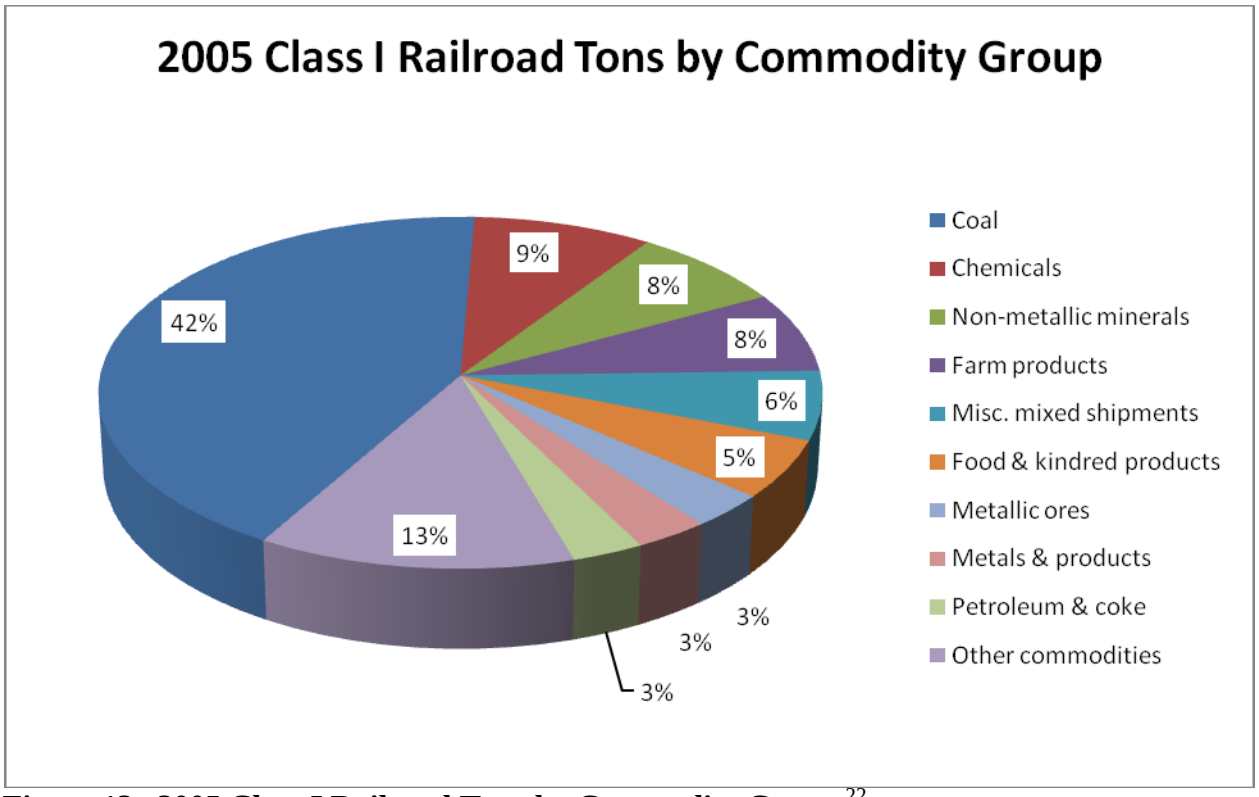


Figure 12. 2005 Class I Railroad Tons by Commodity Group.[22]

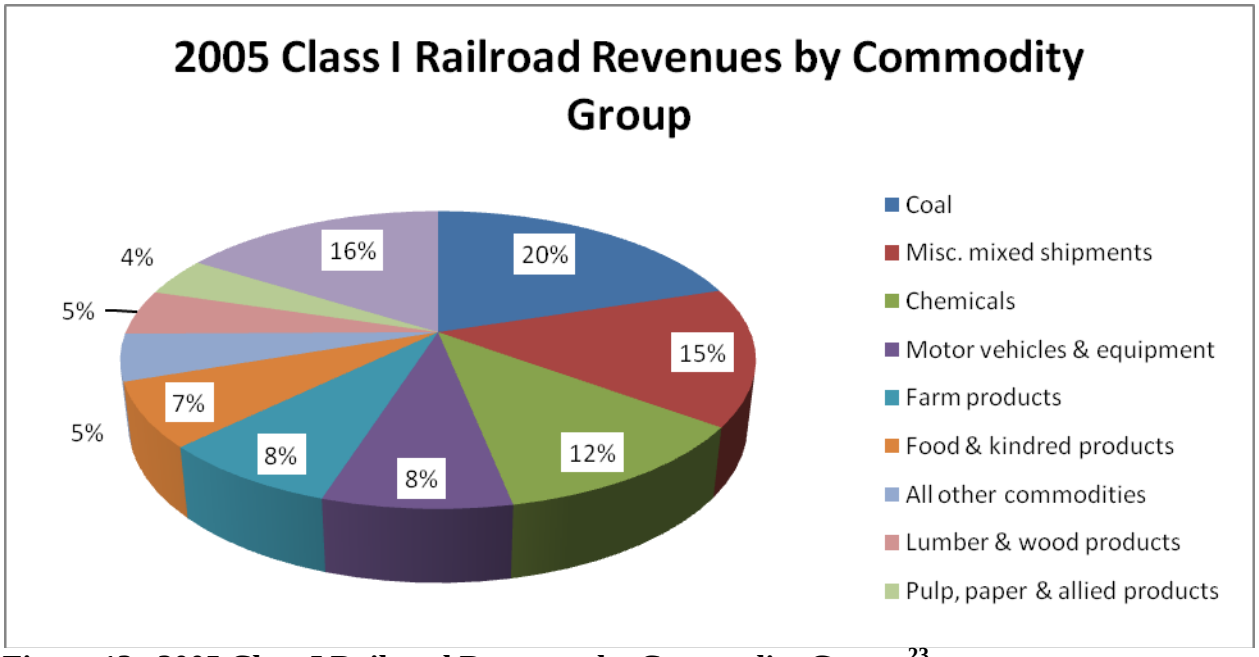


Figure 13. 2005 Class I Railroad Revenues by Commodity Group.[23]

[22] AAR, Class I Railroad Statistics (http://www.aar.org/PubCommon/Documents/AboutTheIndustry/Statistics.pdf)

Waterborne Freight

Waterborne freight transportation is essentially comprised of two distinct sub-modes: inland shipping (also known as "brown water") and coastal and international shipping ("blue" or "deep" water). Internationally, 80% of freight imports (tonnage) arrive in the U.S. via blue water shipping. The inland waterway network is extensive, consisting of approximately 26,000 miles of navigable waterways in the U.S.

Table 3. Domestic Waterborne Freight Activity (Millions of Tons)

	United States		
	1995	2000	2004
Total All Modes	10,184.6	Est.10,109.0	Unavailable
Water transport	1,086.2	1,064.3	1,041.6
Coastal shipping	266.6	226.8	220.6
Great Lakes	116.1	114.4	103.5
Inland waterways	703.4	723.0	717.5

Inland and intracoastal shipping is mainly conducted via towboats and barges and commodities carried tend to be low-value, high-volume bulk products such as grain, coal, gravel, ore and petroleum products. One barge carries the equivalent of 15 jumbo rail hopper cars, or 58 trucks and a single towboat is capable of pushing a flotilla of up to 40 barges.[23]

A challenge facing inland water transport industry is the age of the locks, which account for elevation changes on the river system. Half of the locks on the inland waterway system are more than 50 years old.[25] Many of these locks are not large enough to accommodate routine barge movements, requiring towboats to break flotillas apart and lock through in two sections. These operating constraints with existing traffic levels result in the locks becoming choke points on the waterways. These delays (550,000 hours annually, representing $385 million in increased operating costs[24]) cause unnecessary consumption of fuel by towboats and the mode's reliability and ability to compete with land-based modes such as rail and truck suffers. Figure 14 shows the number of tons moving along the navigable waterway network in 2004.

[23] USACE Inland Waterway Navigation: Value to the Nation. http://www.iwr.usace.army.mil/docs/InlandNavigation.pdf

[24] ASCE: Report Card on Navigable Waterways. http://www.asce.org/reportcard/index.cfm?reaction=factsheet&page=11

Figure 14. Tonnage on Navigable Waterway Network (2004)[25]

Most "blue water" freight is transported via containerships with petroleum and chemical shipments carried on tankers. Containerized cargo offers many advantages to traditional bulk shipments, most notably its versatility of cargoes, reliable transit times, and ability to pack the containers anywhere (not at the dock).

The containerized cargo revolution began in the 1950's and the trend of building larger and faster liner ships does not appear to be slowing down. From 2001 through 2005, the world's containership fleet size grew by 8.1%, but the capacity of the fleet in terms of twenty-foot equivalent units grew 29.2%.[26] As a matter of fact, the increase in the size of maritime liner ships is a major challenge facing waterborne freight as U.S. as ports seek to undertake additional dredging to accommodate the larger vessels and seek financing for larger container cranes need to load and unload vessels. The U.S. Army Corps of Engineers is dredging the Port of New York from 35 feet to 50 feet to accommodate the larger vessels calling on the Ports of New York and New Jersey.[27] The top 5 U.S. ports are displayed in Figure 15 (in terms of total volume), while Figure 16 illustrates the top 5 U.S. ports in terms of import and export value.

[25] USACE Navigation Data Center (Waterborne Commerce Statistics Center)
[26] U.S. Maritime Administration. Vessel Calls at U.S. and World Ports, 2005. Summary tables. http://www.marad.dot.gov/MARAD_statistics/2005%20STATISTICS/Vessel%20Calls%20at%20U%20S%20&%20World%20Ports%202005.pdf
[27] USACE: Harbor Navigation. http://www.nan.usace.army.mil/harbor/deep.htm

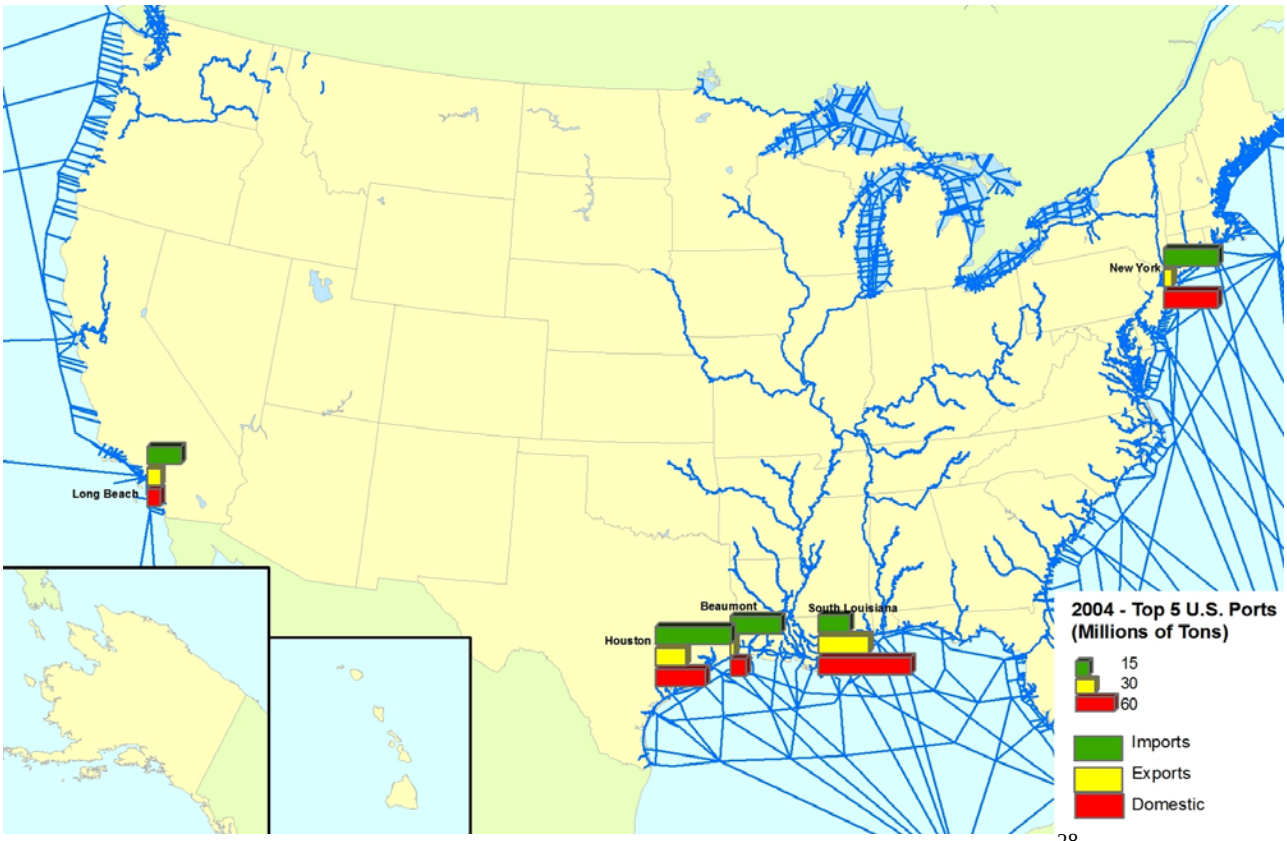


Figure 15. Top 5 U.S. Ports in 2004 (Import, Export and Domestic Tonnage)[28]

[28] USACE Navigation Data Center (Waterborne Commerce Statistics Center)

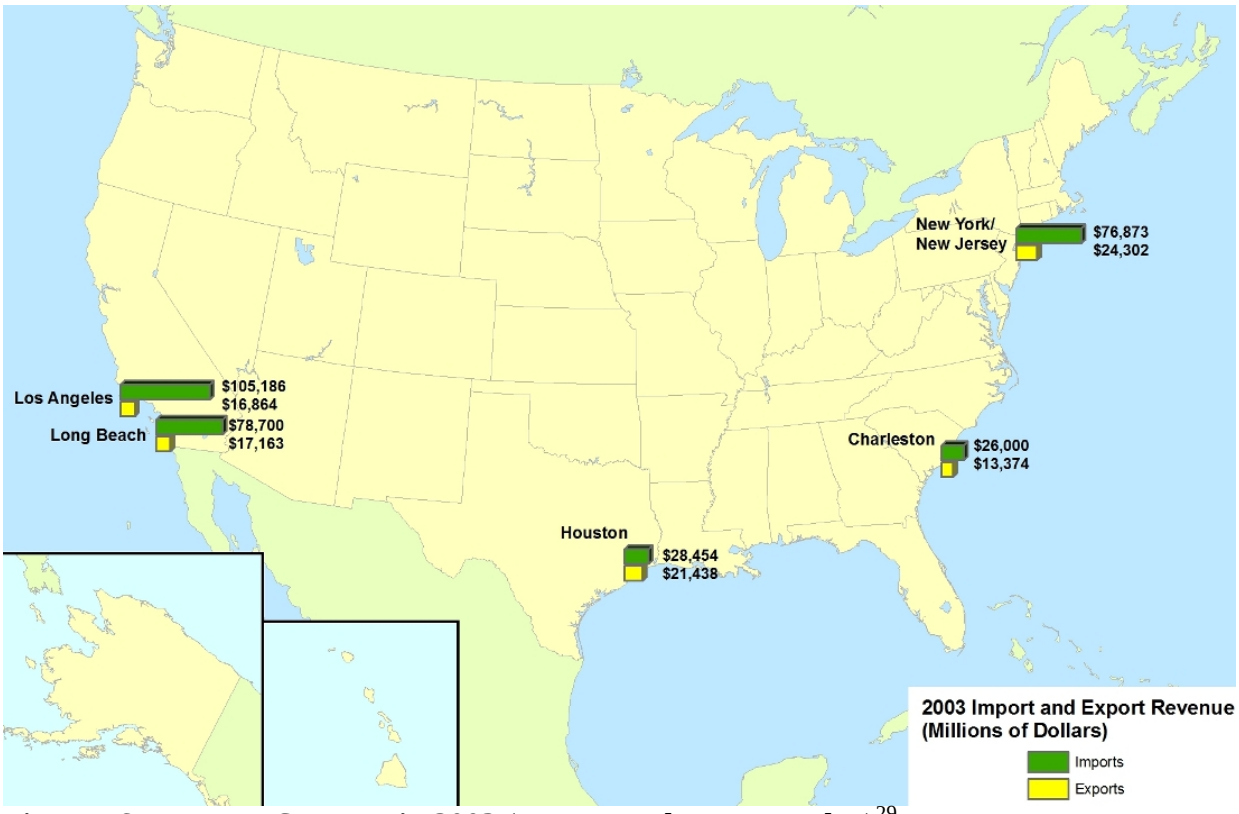


Figure 16. Top 5 U.S. Ports in 2003 (Import and Export Value)[29]

Air Freight

Air freight is a small but growing segment of the overall freight picture. Air freight includes express and mail, and is carried in the cargo bay of passenger airliners as well as dedicated cargo planes. Products transported by air freight are usually small, high value goods of which companies demand timely delivery. This is characterized by the industry transporting 7.4 percent of the value of goods, but only 0.1 percent of the weight (2002). The value of goods shipped by air jumped from $56,000 per ton in 1993 to $75,000 per ton in 2002.[30]

Increases in air freight result in heightened demand for truck and intermodal services. Accordingly, air is included with air and truck movements for statistical purposes. Air freight revenue ton-miles by commercial carriers from 2000-2005 is illustrated Figure 17. Domestic air freight has remained relatively constant while international traffic has increased by 56% between 2002 and 2005.

[29] American Association of Port Authorities (AAPA). 2003 U.S. Port Rankings by Cargo Value. http://www.aapa-ports.org/files/Statistics/2003%5FUS%5FPORT%5FRANKINGS%5FBY%5FCARGO%5FVALUE.xls
[30] BTS Freight Data and Statistics, 2004. http://www.bts.gov/programs/freight_transportation/html/air.html

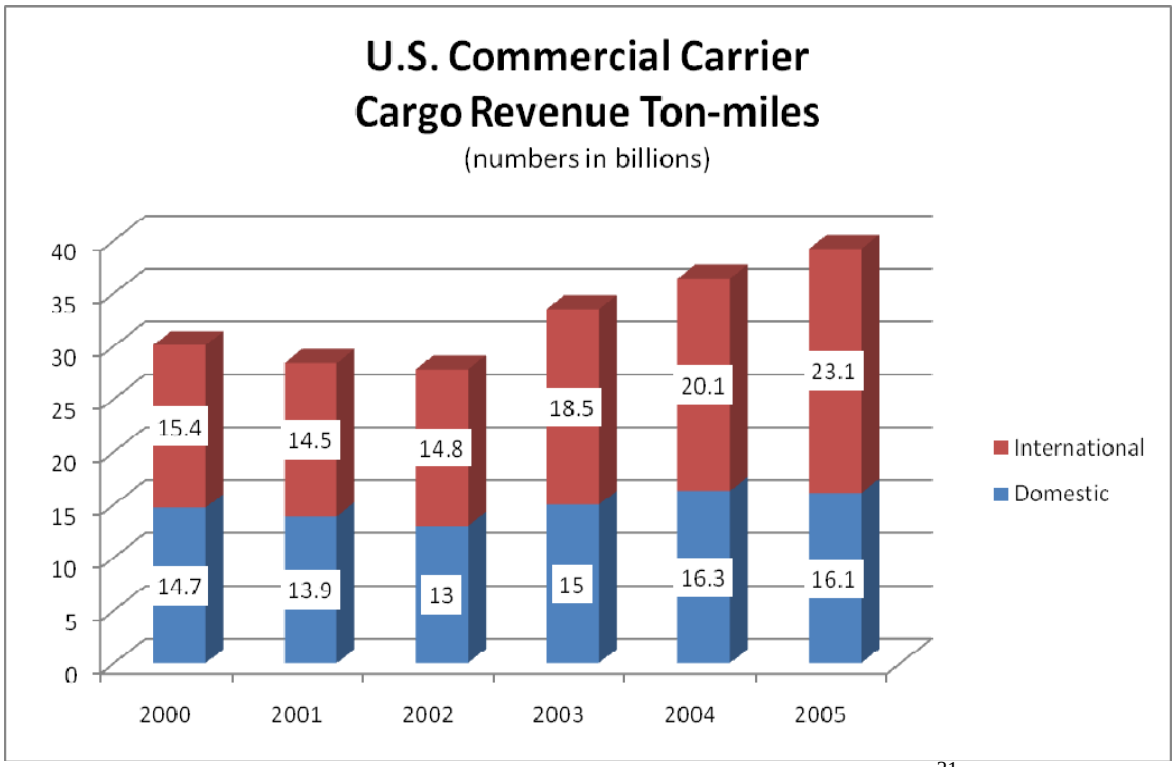


Figure 17. U.S. Commercial Carrier Revenue Ton-miles, 2000-2005[31]

Figure 18 shows the top ten airports in the U.S. in terms of landed cargo weight during 2004. Memphis and Louisville, the hubs of FedEx and UPS, respectively, are two of the top 3 airports. Ted Stevens International Airport in Anchorage, AK is a key international gateway to/from the United States for air freight.

[31] FAA Aerospace Forecast Fiscal Years 2006-2017. Page 16.

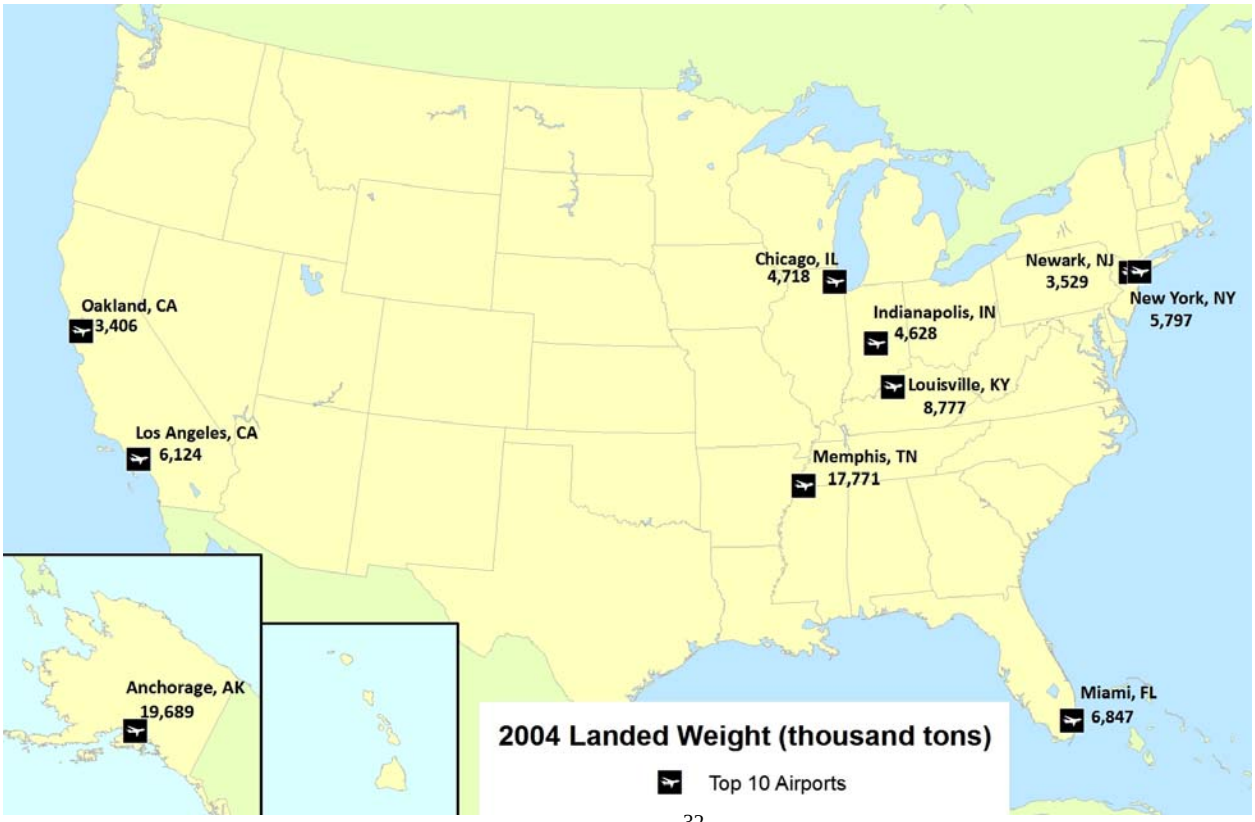


Figure 18. Landed Weight at U.S. Airports, 2004.[32]

Pipeline Freight

The U.S. has more than 2 million miles of pipelines operated by over 3,000 companies. This mode of transportation is largely taken for granted as most pipelines are located below the surface.[33] The Trans Alaska Pipeline System (TAPS) consists of an 800 mile network of 48 inch diameter above-ground pipes transporting up to two million barrels of crude oil per day from the North Slope of Alaska (Prudhoe Bay) to Valdez, AK.[34] In Valdez, the northernmost ice-free port in Alaska, tankers transport the crude oil to the continental U.S.

Figure 19 illustrates the expansive coverage of the pipeline network in the U.S.

[32] FHWA. "Freight Facts and Figures, 2006." Table 2-12.
[33] PHMSA, Stakeholder Communications: Pipeline Basics, http://primis.phmsa.dot.gov/comm/PipelineBasics.htm
[34] Alyeska Pipeline Facts. http://www.alyeska-pipe.com/pipelinefacts.html

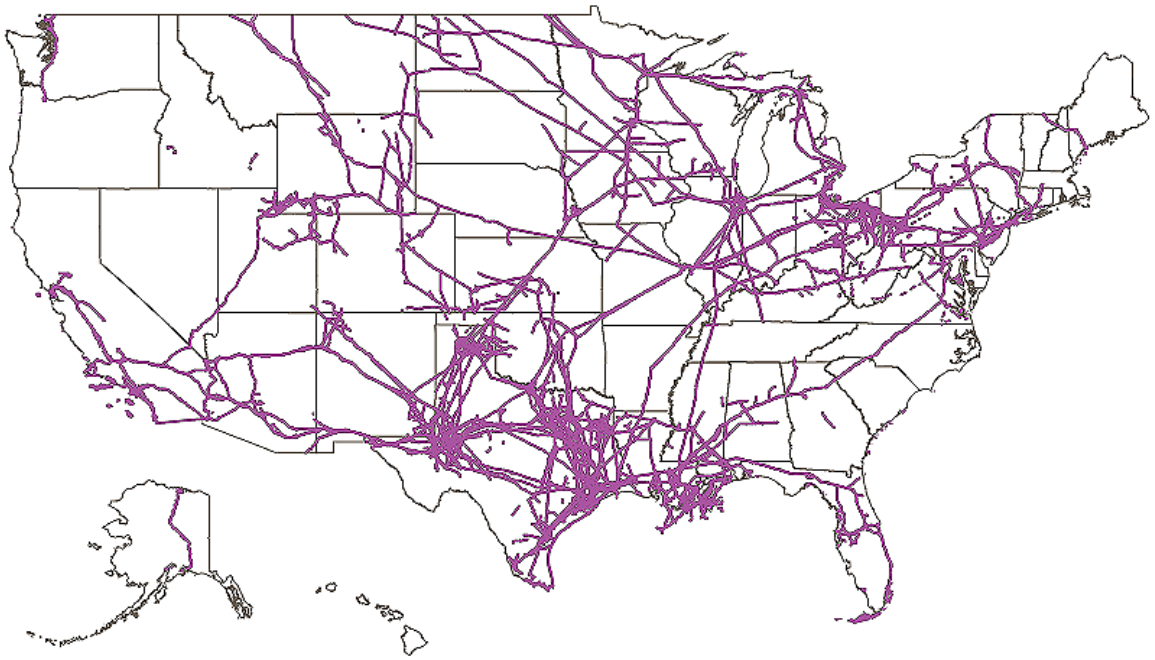


Figure 19. 12" or Greater Pipelines in the United States[35]

There are two general types of pipelines, oil and natural gas. Within the oil pipeline category there are crude oil pipelines and refined product pipelines. Crude oil pipelines move the raw material from the drilling location to refineries and processing locations. Refined product pipelines carry products such as diesel, home heating oil, aviation fuel, gasoline and feedstocks. These pipelines connect the processing locations with distribution centers, where tanker trucks carry the products to their final destinations. Pipelines transport two thirds of all U.S. crude oil and petroleum product ton-miles (Figure 21). In 2002, pipelines moved 22% of the value and 30.2% of the volume of hazardous materials.[36] The safety performance of the pipeline industry has improved substantially over the past 30 years, mainly due to the automation of control systems.

[35] GAO presentation of Bureau of Transportation statistics, TSA, and FTA data. "Transportation Security", United States Government Accountability Office Report GAO-03-843, June 2003

[36] BTS: National Transportation Statistics. Table 1-56, U.S. Hazardous Materials Shipments by Transportation Mode, 2002. http://www.bts.gov/publications/national_transportation_statistics/html/table_01_56.html

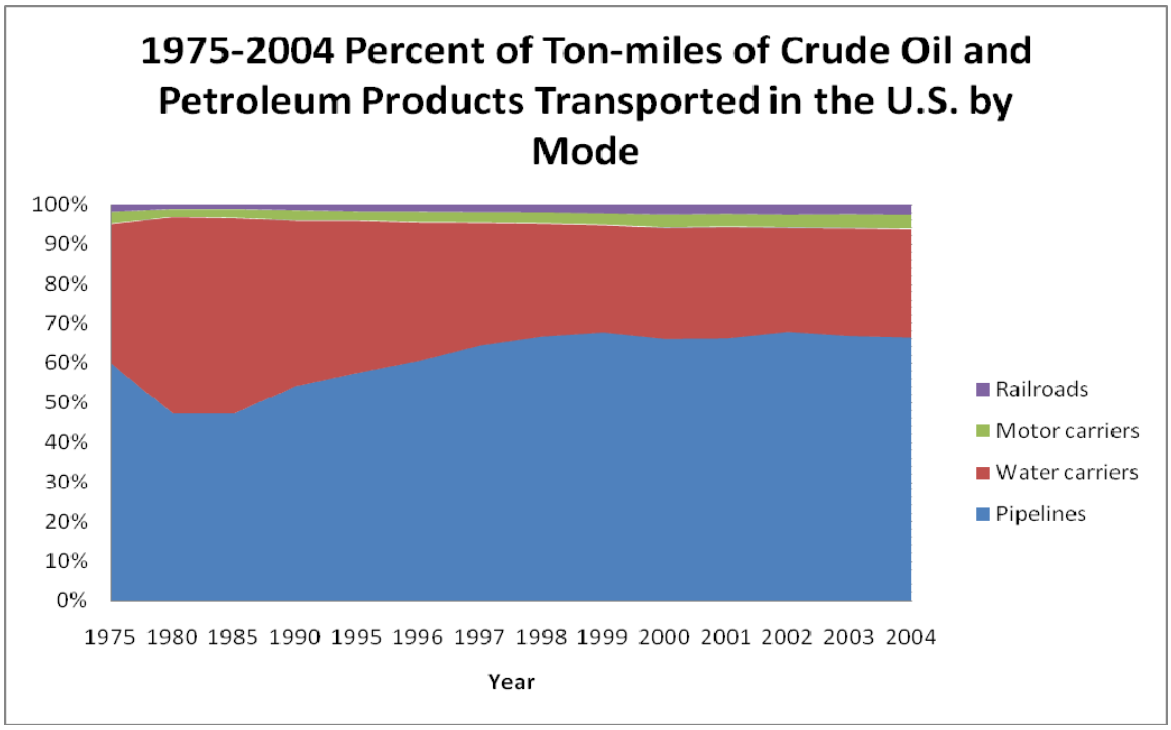


Figure 20. 1975-2004 Percent of Ton-miles of Crude Oil and Petroleum Products Transported by Mode[37]

Future Growth

The amount of freight moved in the next 27 years is expected to nearly double over the amount moved in 2002 and the value of that freight moved will nearly triple with much of that growth in the intermodal movements. The growth from 2002 to 2035 is illustrated in Table 4.

[37] BTS National Transportation Statistics, Table 1-55.
http://www.bts.gov/publications/national_transportation_statistics/html/table_01_55.html

Table 4. Expected Growth in Freight Movements from 2002 to 2035[38]

	2002		2035	
	Millions of Tons	**Billions of Dollars**	**Millions of Tons**	**Billions of Dollars**
Total	(P) 19,326	(P) 13,120	(P) 37,178	(P) 38,399
Truck	11,539	8,856	22,814	23,767
Rail	1,879	382	3,525	702
Water	701	103	1,041	151
Air, air & truck	(P) 10	(P) 663	(P) 27	(P) 455
Intermodal[1]	1,292	1,967	2,598	8,966
Pipeline and unknown[2]	3,905	1,149	7,172	2,357

Key: P = preliminary

[1]Intermodal includes U.S. Postal Service and courier shipments and all intermodal combinations, except air and truck.

[2]Pipeline and unknown shipments are combined because data on region-to-region flows by pipeline are statistically uncertain

Note: Numbers may not add to total due to rounding.

[38] U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, 2006.