



# *Transportation & Supply Chain Trends*

SCM614

WEEK 7



# *Agenda*

- Transportation, chapter 14
- SC trends, 5 Levers
- Final review

# *Transportation Modes and Their Role in a Supply Chain*

- Movement of product from one location to another
- Products rarely produced and consumed in the same location
- Significant cost component
- **Shipper** requires the movement of the product
- **Carrier** moves or transports the product

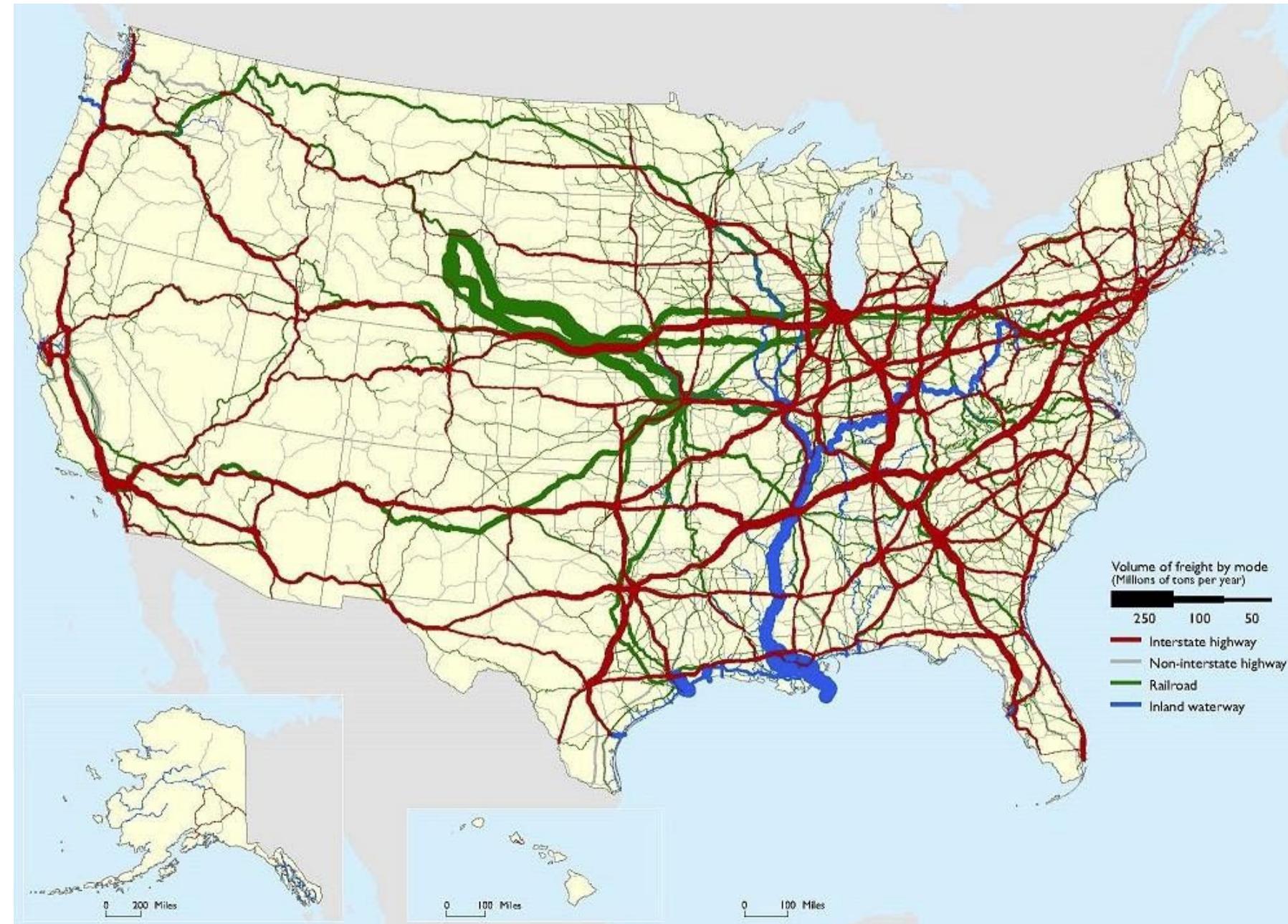
# *Modes of Transportation and Their Performance Characteristics*

- Air
- Package carriers
- Truck
- Rail
- Water
- Pipeline
- Intermoda

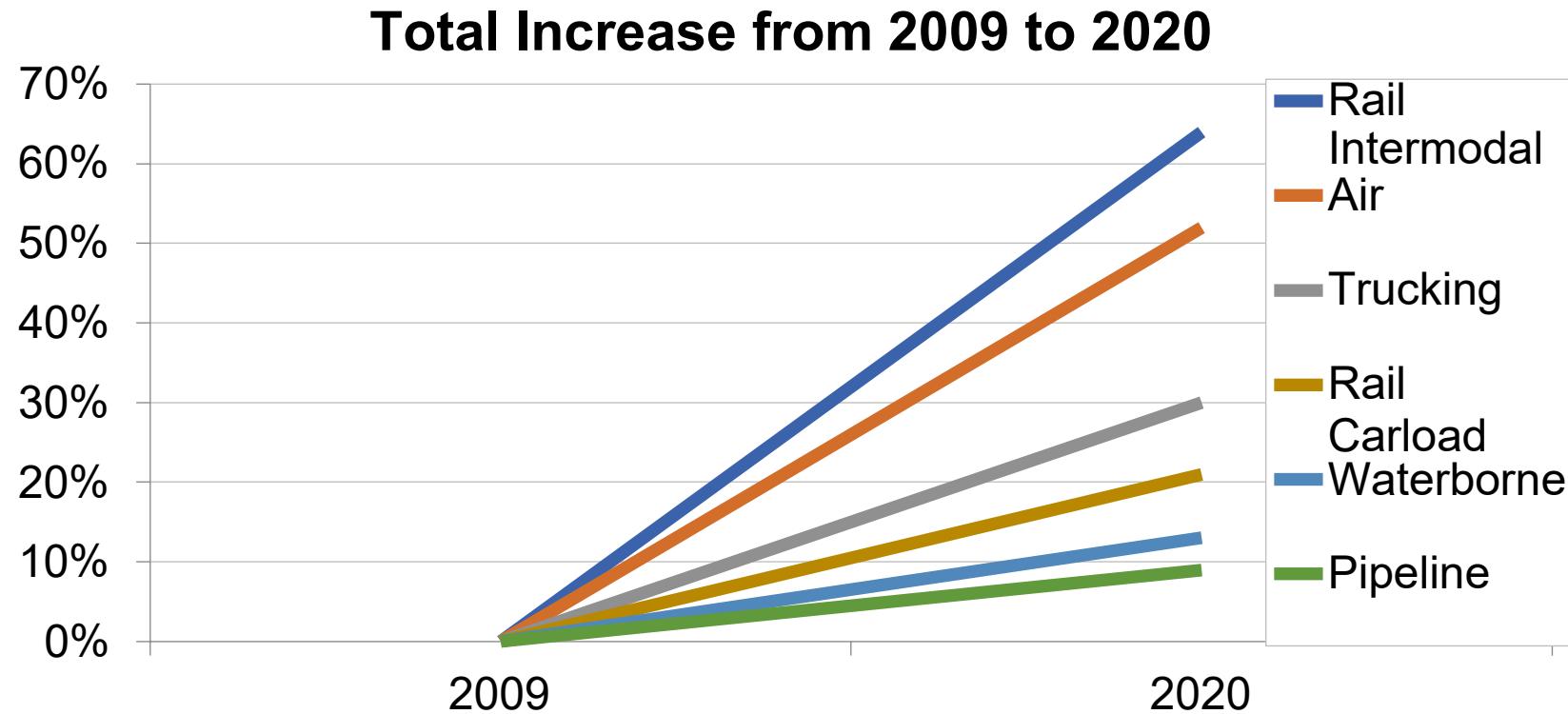
Domestic Mode	Weight (thousands of tons)	Value (millions of current dollars)
Truck	11,520,318	12,421,511
Rail	1,738,346	690,459
Water	766,322	363,500
Air (including truck-air)	5,871	591,253
Multiple modes and mail	495,680	2,328,112
Pipeline	3,049,857	942,007
Other and unknown	39,210	97,633
No domestic mode	208,676	66,410
Total (All modes)	17,824,281	17,500,885

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5, 2019.

# *Freight Flows by Highway, rail, & water (2012)*



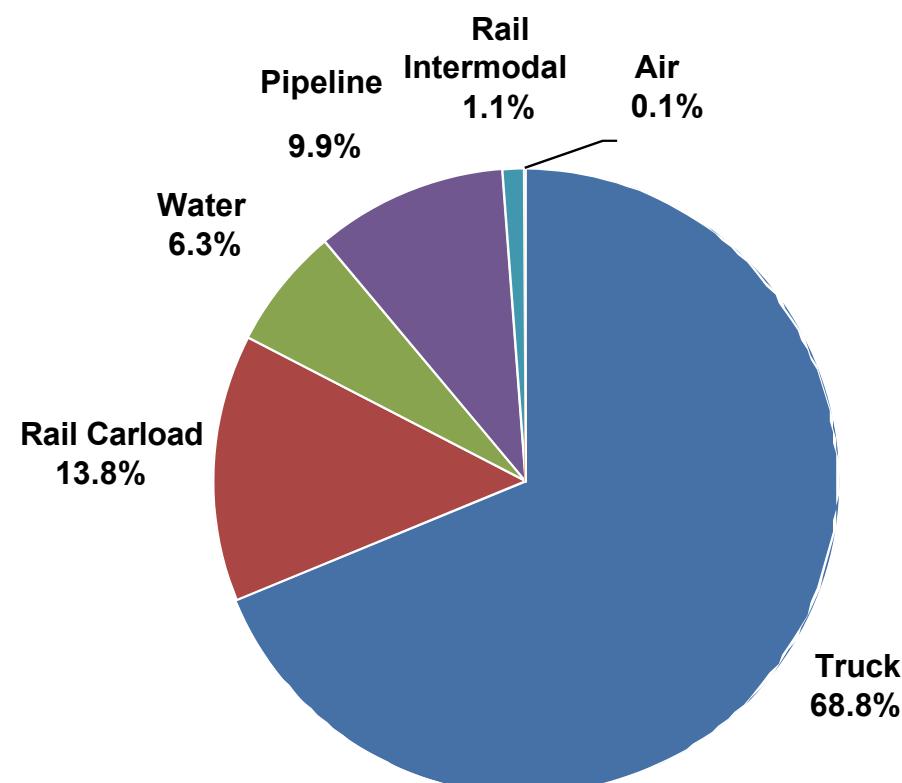
# *Growth in tonnage*



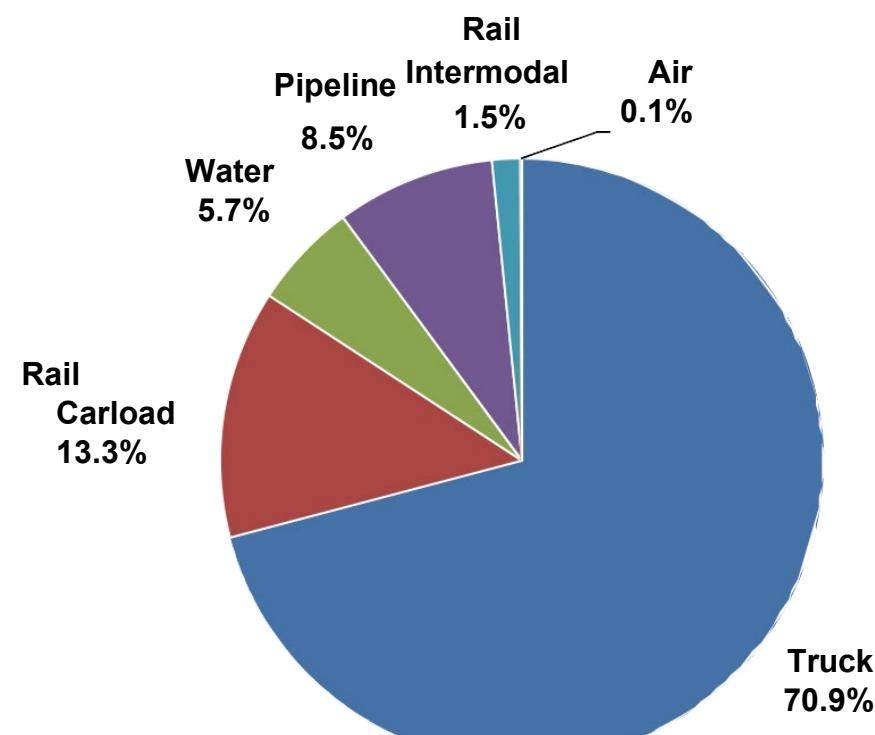
Source: IHS Global Insight  
and ATA.

# *Distribution of tonnage by mode: 2008 vs. 2020*

**2008**



**2020**



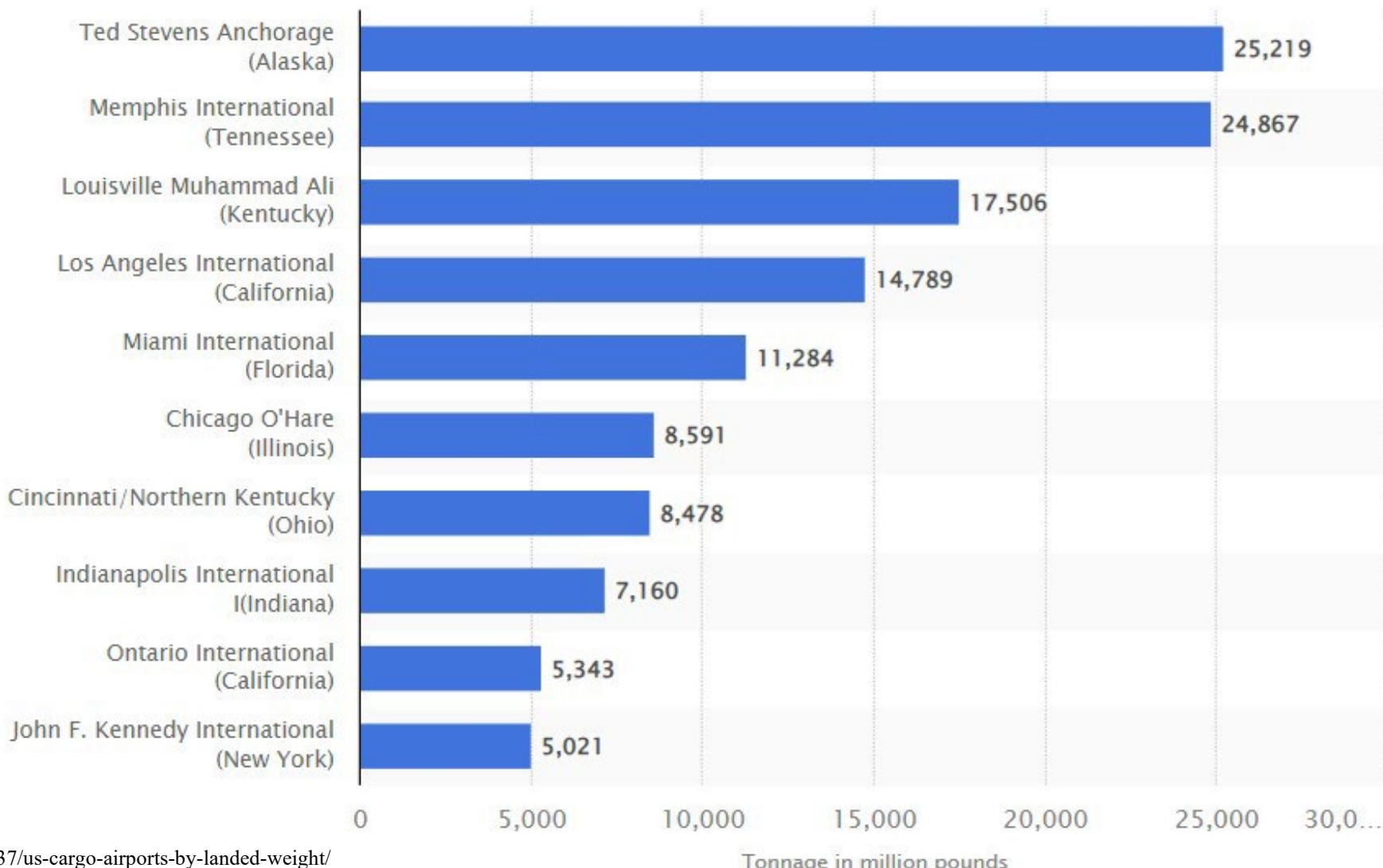
Source: U.S. Freight Transportation Forecast to...2020.

# *Air*

- Cost components
  - Fixed infrastructure and equipment
  - Labor and fuel
  - Variable depending on passenger/cargo
- Key issues
  - Location/number of hubs
  - Fleet assignment
  - Maintenance schedules
  - Crew scheduling
  - Prices and availability



# Air: Top 10 North American cargo airports in 2021 (tonnage in million pounds)



# *Package Carriers*

- Small packages up to about 150 pounds
- Expensive
- Rapid and reliable delivery
- Small and time-sensitive shipments
- Provide other value-added services
- Consolidation of shipments a key factor



# *Truck*

- Significant fraction of the goods moved
- Truckload (T L)
  - Low fixed cost
  - Imbalance between flows
- Less than truckload (L T L)
  - Small lots
  - Hub and spoke system
  - May take longer than T L
- Fatigue-related accidents



# *Rail*

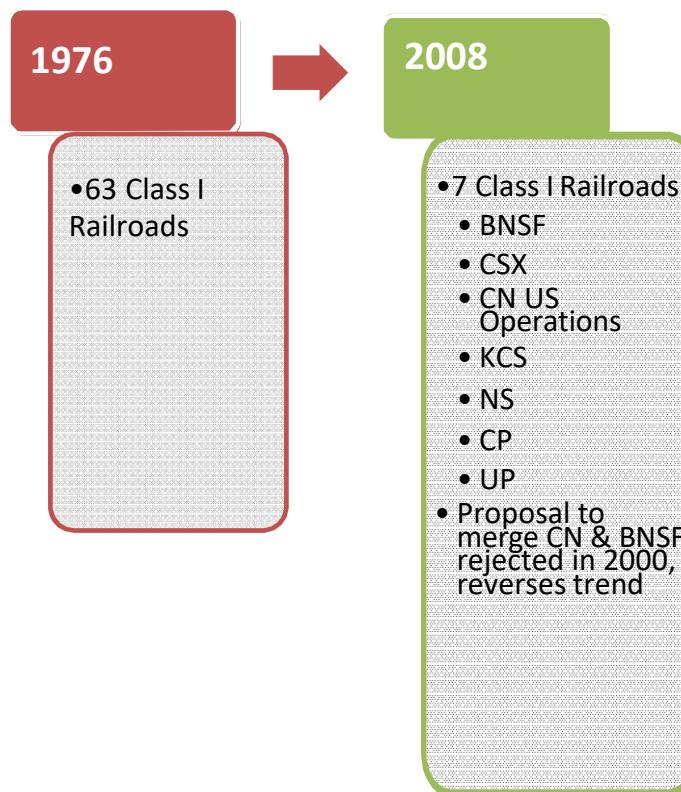
- Move commodities over large distances
- High fixed costs in equipment and facilities
- Scheduled to maximize utilization
- Transportation time can be long
  - Trains ‘built’ not scheduled



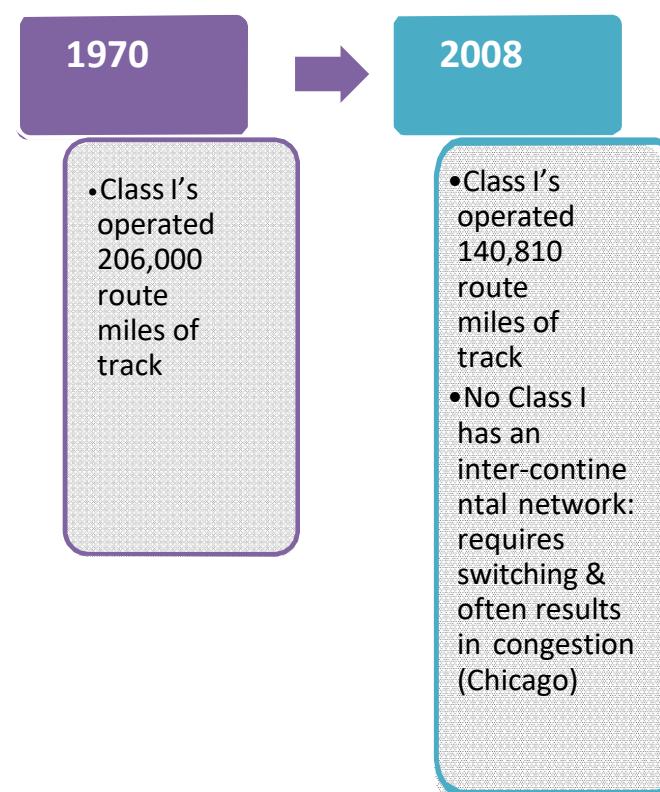
BNSF Container train in the Cajon Pass - by "GGG" via  
<http://www.roadfood.com/Forums>

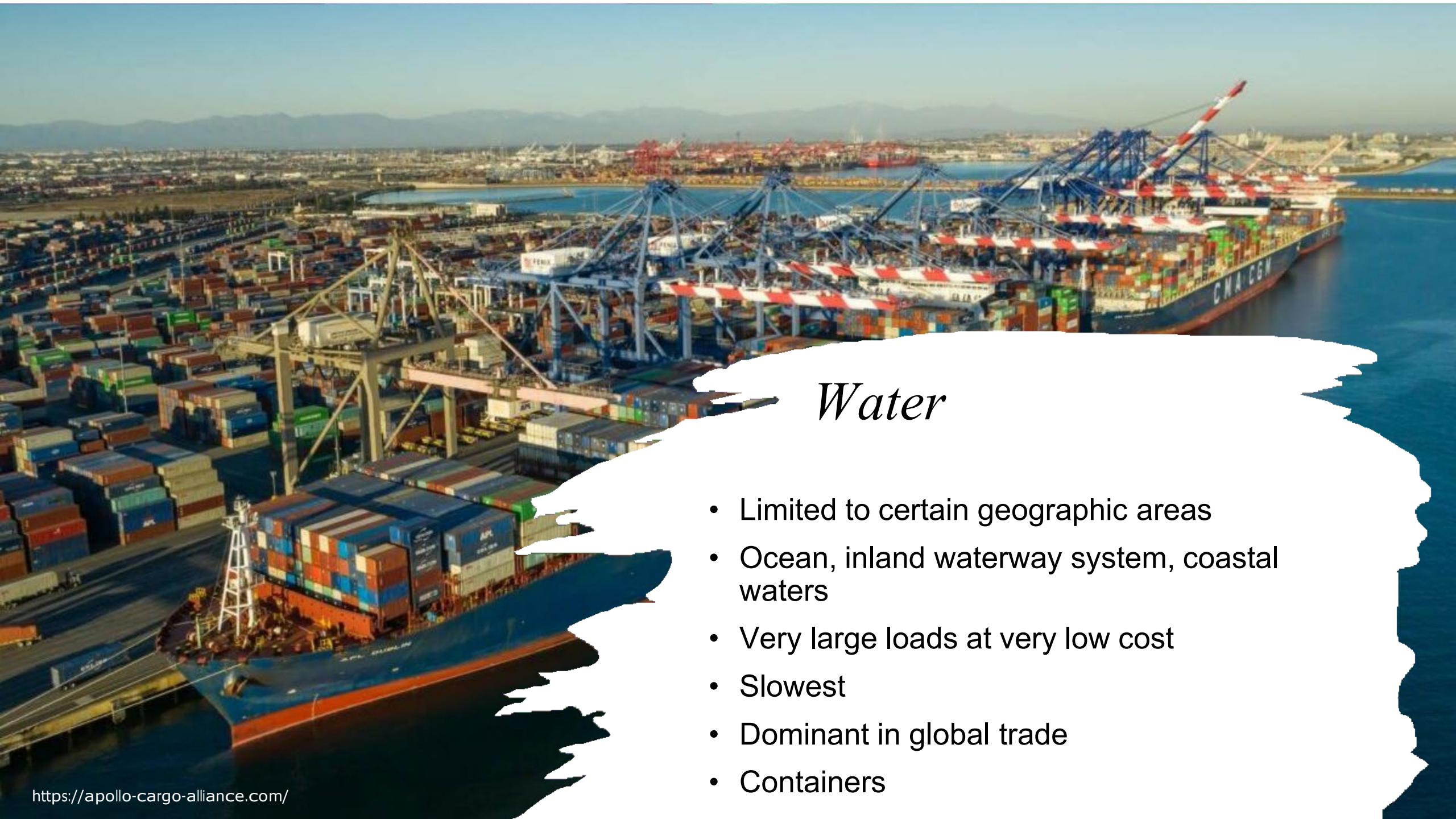
# Railroads: Impacts of deregulation

## Number of railroads



## Route miles operated

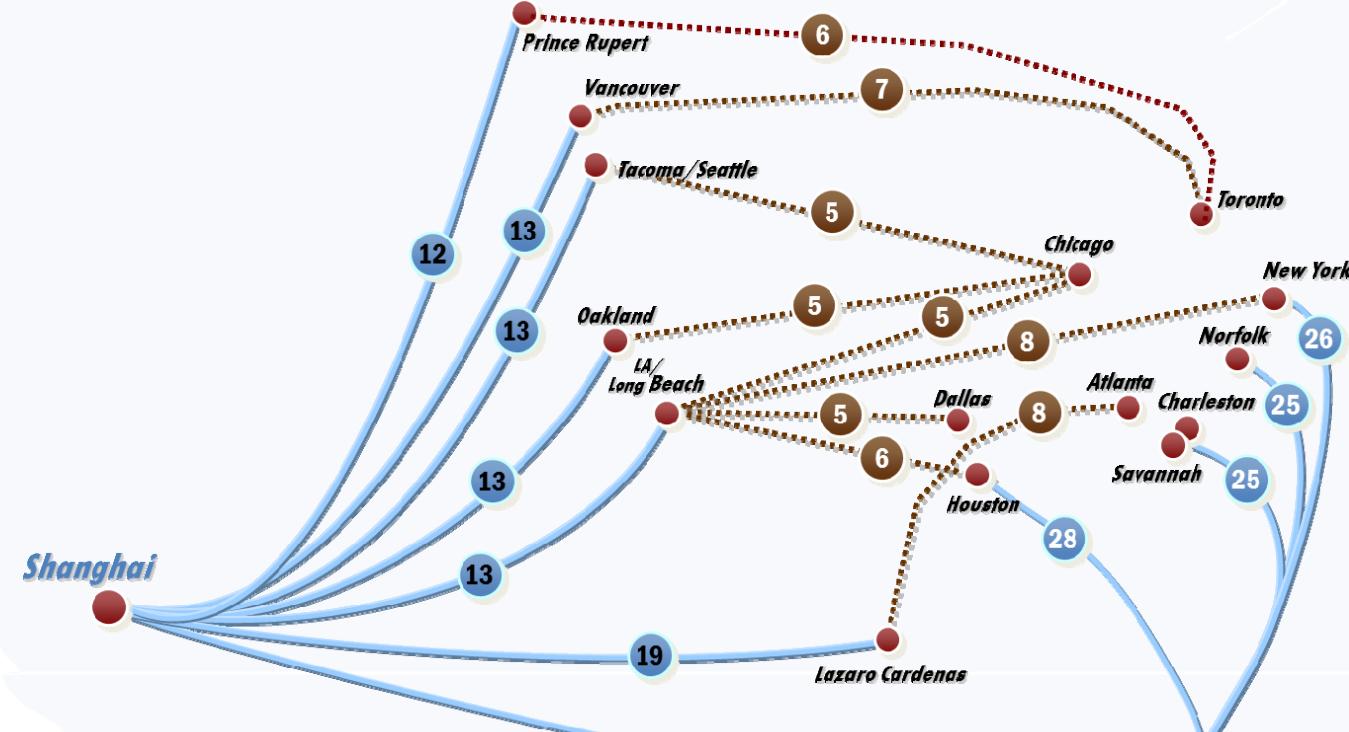




## *Water*

- Limited to certain geographic areas
- Ocean, inland waterway system, coastal waters
- Very large loads at very low cost
- Slowest
- Dominant in global trade
- Containers

# *Water: Transit times*



# *Water: America's marine highways*



# Water

- The combined capacity of the top 10 ocean carriers is 18 million TEUs in 2018
  - Danish carrier **Maersk Line** retained its overall lead with capacity of 4.1 million TEUs; market share at 17.7% (<https://cargofive.com/top-10-ocean-carriers-around-the-world/>)
- As of January 2018, 53,732 ships were in the world's merchant fleet (<https://www.statista.com/statistics/264024/number-of-merchant-ships-worldwide-by-type/>)

Port Name	2018 Total Container Volume (TEUs)	% of Traffic	Annual Change 2018 vs 2017	2017 Total Container Volume (TEUs)	Comments
Los Angeles	9,458,751	19.8%	1.24%	9,343,192	Combined with Long Beach = 17.5M TEUs in 2018 (up 3.9% yoy). Ranked #9 in the world.
Import Volume	4,870,585	21.9%	3.28%	4,716,089	Port of Los Angeles moved more cargo in 2018 than any time in its 111-year history.
Export Volume	1,904,054	15.1%	0.22%	1,899,934	
Long Beach	8,091,029	16.9%	7.24%	7,544,514	Combined with Los Angeles = 17.5M TEUs in 2018 (up 3.9% yoy). Ranked #9 in the world. Surpassed 8 million TEUs for the first time in its history.
Import Volume	4,097,379	18.4%	6.06%	3,863,189	Nearly 70% of the port's import containers come from China.
Export Volume	1,523,011	12.1%	3.57%	1,470,517	
New York/New Jersey	7,179,792	15.0%	6.99%	6,710,817	Surpassed 7M TEUs for first time in its history, which dates back to the 1950s.
Import Volume	3,676,113	16.5%	8.23%	3,396,469	Port handled one third of all containers on the East Coast of North America.
Export Volume	1,476,780	11.7%	4.34%	1,415,322	
Savannah, GA	4,351,976	9.1%	7.56%	4,046,216	Highest annual volume ever. Nine of the port's 10 busiest months were in 2018.
Import Volume	2,081,368	9.3%	10.96%	1,875,833	In December alone, the Port of Savannah handled 351,366 TEUs, an increase of 8.7%.
Export Volume	1,444,403	11.4%	5.24%	1,372,453	



# *Pipeline*

- High fixed cost
- Primarily for crude petroleum, refined petroleum products, natural gas
- Best for large and stable flows
- Pricing structure encourages use for predictable component of demand

# *Intermodal*

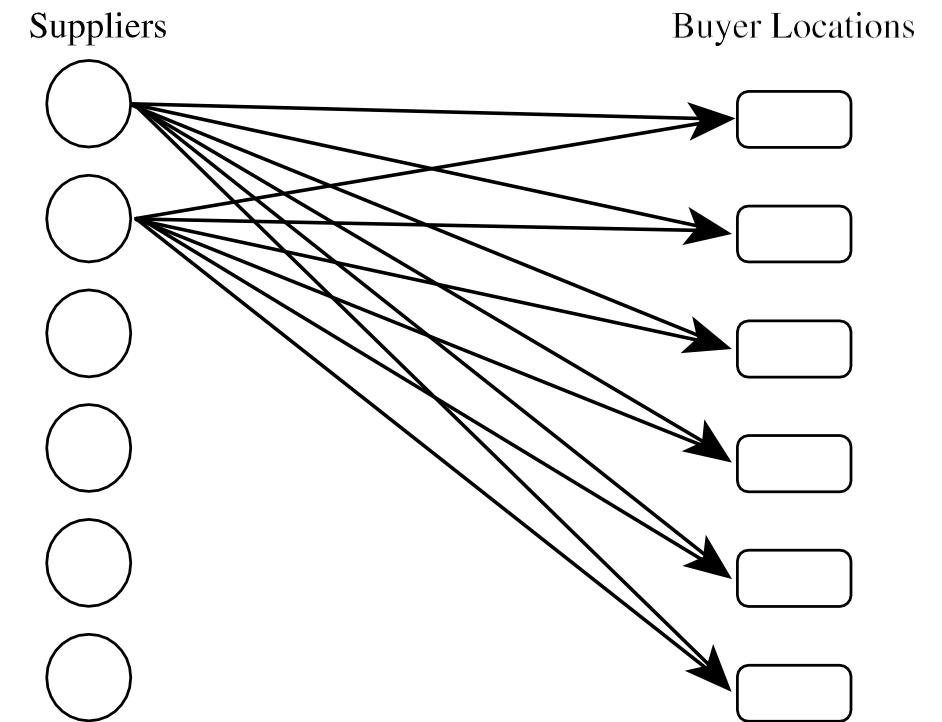


- Use of more than one mode of transportation to move a shipment
- Grown considerably with increased use of containers
- May be the only option for global trade
- More convenient for shippers – one entity
- Key issue – exchange of information to facilitate transfer between different modes

# *Design Options for a Transportation Network*

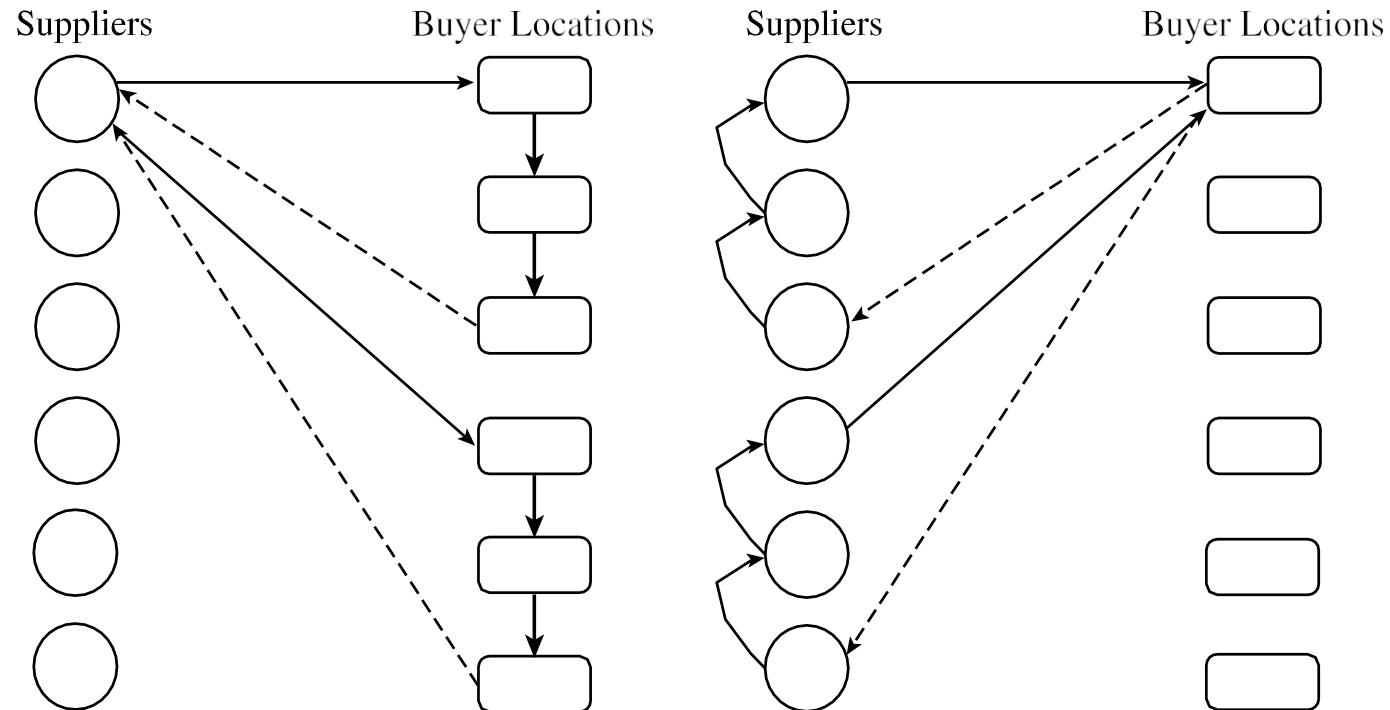
- When designing a transportation network
  1. Should transportation be direct or through an intermediate site?
  2. Should the intermediate site stock product or only serve as a cross-docking location?
  3. Should each delivery route supply a single destination or multiple destinations?

*Direct Shipment  
Network to Single  
Destination*



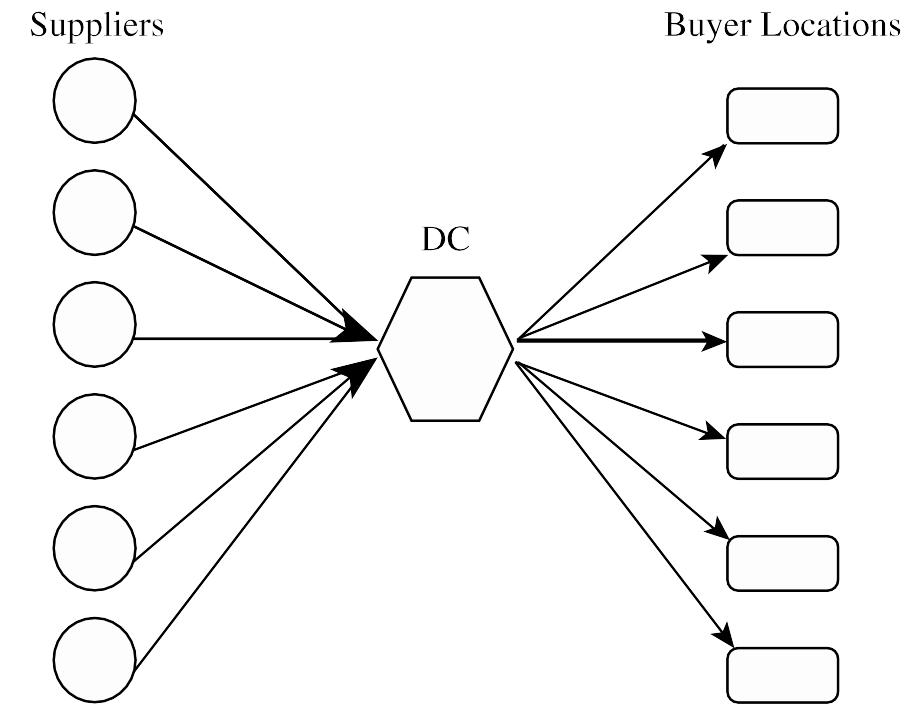
**Figure 14-2** Direct Shipment Network

# *Direct Shipping with Milk Runs*

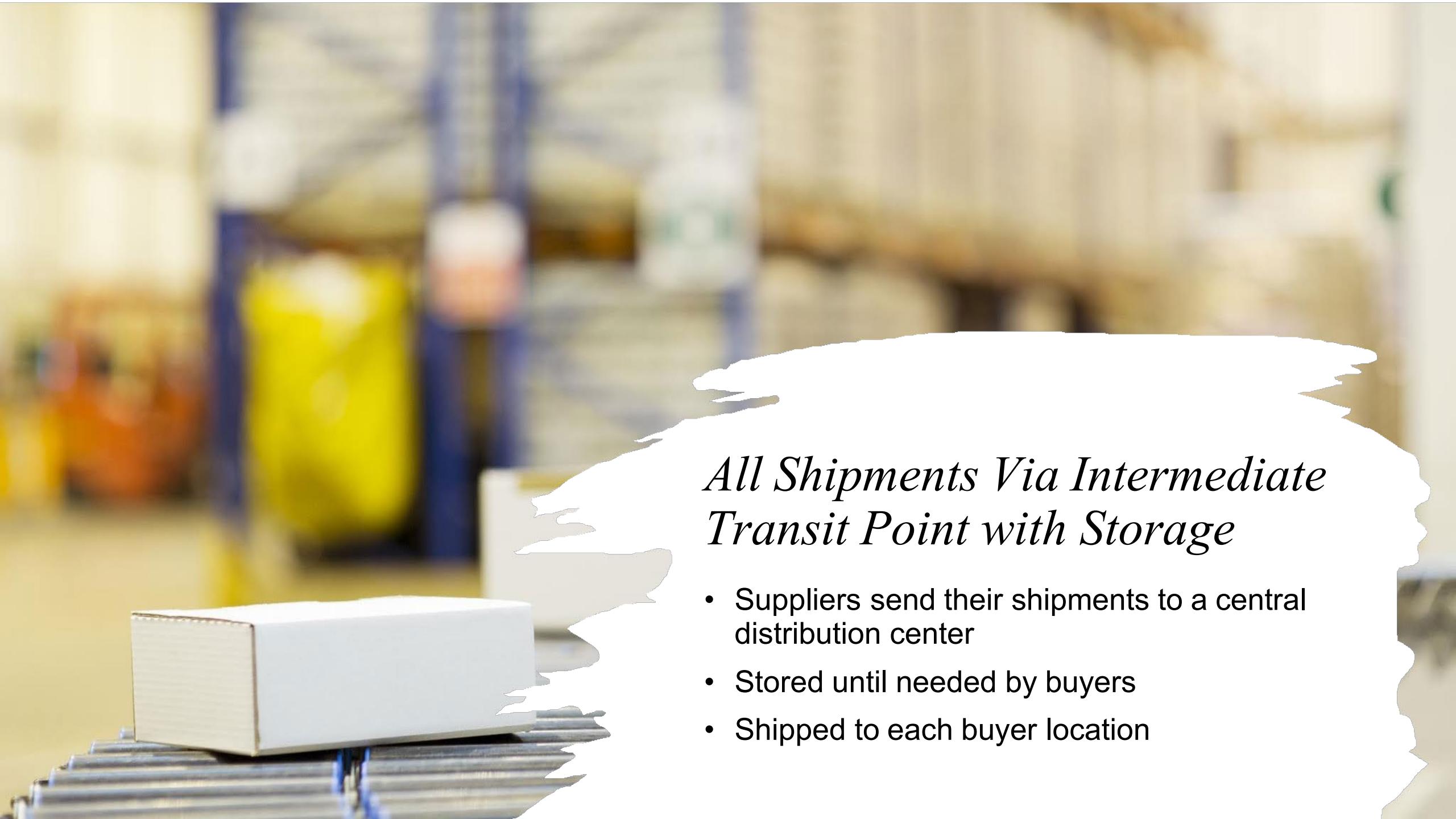


**Figure 14-3** Milk Runs from Multiple Suppliers or to Multiple Buyer Locations

*All Shipments Via Intermediate  
Distribution Center with Storage*



**Figure 14-4** All Shipments via D C



*All Shipments Via Intermediate  
Transit Point with Storage*

- Suppliers send their shipments to a central distribution center
- Stored until needed by buyers
- Shipped to each buyer location

## *All Shipments Via Intermediate Transit Point with Cross- Docking*

- Suppliers send their shipments to an intermediate transit point
- They are cross-docked and sent to buyer locations without storing them



# *Tailored Network*

**Table 14-2** Pros and Cons of Different Transportation Networks

Network Structure	Pros	Cons
Direct shipping	No intermediate warehouse Simple to coordinate	High inventories (due to large lot size)
Direct shipping with milk runs	Lower transportation costs for small lots Lower inventories	Increased coordination complexity
All shipments via central DC with inventory storage	Lower inbound transportation cost through consolidation	Increased inventory cost Increased handling at DC
All shipments via central DC with cross-dock	Low inventory requirement Lower transportation cost through consolidation	Increased coordination complexity
Shipping via D C using milk runs	Lower outbound transportation cost for small lots	Further increase in coordination complexity
Tailored network	Transportation choice best matches needs of individual product and store	Highest coordination complexity

# *Mumbai Dabbawalas*



- Lunchbox delivery system
- Factors facilitating success
  - 1. Low uncertainty of demand
  - 2. Temporal aggregation of demand
  - 3. Use of transportation resources when they are underutilized

# *Trade-Offs in Transportation Design*

**Table 14-3** Ranking of Transportation Modes in Terms of Supply Chain Performance (Read Vertically, 1 = Lowest, 6 = Highest)

Mode	Cycle Inventory	Safety Inventory	In-Transit Cost	Transportation Cost	Transportation Time
Package	1	1	1	6	1
Air	2	2	2	5	2
LTL	3	3	3	4	4
TL	4	4	4	3	3
Rail	5	5	5	2	5
Water	6	6	6	1	6



## *Inventory Aggregation*

- Can significantly reduce safety inventories
- Transportation costs generally increase
- Use
  - When inventory and facility costs form a large fraction of a supply chain's total costs
  - For products with a large value-to-weight ratio
  - For products with high demand uncertainty



## *Trade-Off between Transportation Cost and Customer Responsiveness*

- Closely linked to degree of responsiveness
  - High responsiveness, high transportation costs
  - Decreased responsiveness, lower transportation costs
- **Temporal aggregation** – combining orders across time



## *Tailored Transportation (1 of 3)*

- The use of different transportation networks and modes based on customer and product characteristics
- Factors affecting tailoring
  - Customer density and distance
  - Customer size
    - Transportation cost based on total route distance
    - Delivery cost based on number of deliveries
  - Product demand and value

# *Tailored Transportation (2 of 3)*

**Table 14-10** Transportation Options Based on Customer Density and Distance

	<b>Short Distance</b>	<b>Medium Distance</b>	<b>Long Distance</b>
High density	Private fleet with milk runs	Cross-dock with milk runs	Cross-dock with milk runs
Medium density	Third-party milk runs	LTL carrier	LTL or package carrier
Low density	Third-party milk runs or LTL carrier	LTL or package carrier	Package carrier

# *Tailored Transportation (3 of 3)*

**Table 14-11** Aggregation Strategies Based on Value/Demand

<b>Product Type</b>	<b>High Value</b>	<b>Low Value</b>
High demand	Disaggregate cycle inventory. Aggregate safety inventory. Inexpensive mode of transportation for replenishing cycle inventory and fast mode when using safety inventory.	Disaggregate all inventories and use inexpensive mode of transportation for replenishment.
Low demand	Aggregate all inventories. If needed, use fast mode of transportation for filling customer orders.	Aggregate only safety inventory. Use inexpensive mode of transportation for replenishing cycle inventory.

# *Qualitative checklist of alternative transportation modes*

	Truck	Rail	Air	Water	Pipeline
Capacity	Moderate	High	Moderate	Very high	High
Variable cost	Moderate	Low	High	Low	Very low
Fixed cost	Low	High	Low	Moderate	High
Lead time	Moderate	Long	Short	Long	Moderate
Lead time reliability	Moderate	Low	High	Moderate	Very high
Availability of service	High	Moderate	Moderate	Moderate	Low
Typical products and shipment distances	Wide variety of products shipped over a wide range of distances	Raw materials, autos, machinery shipped over long distances (e.g., >500 miles)	Small, high-value, perishable, or time-sensitive product shipped over long distances (e.g., >500 miles)	Inland: raw materials shipped over long distances (e.g., >300 miles) Ocean: wide variety shipped over long distances	Liquids and gasses shipped over a range of distances

Source: Transportation Management Elements and Insights (Chapter 10).

# PP: How would you ship?



## Dropbox PP week 7:

- 1) What commodity
- 2) Mode and why (be specific for route)
- 3) Pros and cons of mode selected



Images:

<https://www.tomsguide.com/us/sony-x690e-70-inch-tv,review-5333.html>  
<https://www.publicdomainpictures.net/en/view-image.php?image=136500&picture=coffee-beans>  
<https://www.behance.net/gallery/15837939/ZARA-logo-redesign>  
<https://christiansiriano.com/collections/dresses>  
<https://www.mousetrapcheese.co.uk/brie-de-meaux-cheese-strong-smelly-french-brie-110-p.asp>  
<https://digitalbachat.in/tech-news/apple-iphone-13-mini-price-in-india/>  
<https://www.mahalaxmimedicos.com/product-details/johnsons-baby-shampoo>



commodity	from	to
TV	Malaysia	Dallas
Zara clothing	Spain	San Diego
couture dress	New York	Mumbai
baby shampoo	midwest	LA
coffee	Columbia	Seattle
iPhone	China	Long Beach
cheese	France	Chicago





[FIGURE 1] 10 TOP TRENDS TO WATCH IN 2019



1. Trade wars drive manufacturing network restructuring  
Brexit, new import tariffs, and other trade barriers will continue to reshape manufacturing supply chains



2. Rising demand & fragile supply create critical raw material shortages  
Political instability and supplier shutdowns likely to impact the supply of crucial raw materials such as lithium, cobalt, and adiponitrile



3. Recalls & safety scares put quality under scrutiny  
Stricter regulations and quality requirements will put pharmaceutical companies under pressure



4. Climate change impact heats up  
Companies likely to face an increasing number of weather-related disruptions, as 2019 is forecasted to be the warmest year on record



5. Tougher environmental regulations make polluters pay  
Local quality and climate change mitigation policies appear across Asia-Pacific



6. Economic uncertainty & structural change put suppliers under threat  
Supplier insolvencies set to rise as small producers continue to be casualties of economic uncertainty and structural change



7. Cargo caught up in industrial unrest  
Early indication of industrial disputes threaten to disrupt transport operations



8. Hazardous transport: container ship fires  
Insufficient firefighting capabilities and a trend towards larger container ships to put pressure on maritime-dependent supply chains



9. Battles at the border to increase wait times  
Companies dependent on U.S.-Mexico and EU-U.K. lanes are likely to see increased costs and border-crossing wait times



10. Drones strike a blow to aviation safety  
Close-proximity drone aviation safety incidents are likely to become more frequent, presenting a greater risk to aviation logistics operations

# 2019 Top Ten Global Supply Chain Risks

# *Then we had Covid...*

## *2021 Top Global Supply Chain Trends*

- 1 ➤ Shorter, more localized supply chains**
- 2 ➤ Insolvencies among smaller and more specialized suppliers**
- 3 ➤ Continued cyber attacks on production sites and logistics operators**
- 4 ➤ Persistent air cargo constraints**
- 5 ➤ Increasing use of multimodal solutions**

# *Other Supply Chain Problems*

- Some emerging markets lack suitable distribution systems, i.e., roads, rail systems
- Existing ports may be inadequate
- Market instability, political instability



# *Congestion*

- Congestion at capacity bottlenecks represents **40%** of all congestion delay.
- In 1982: **35%** of the major road system was congested
- By 2003: that figure rose to **65%**.
- By 2020: 29% of urban NHS routes congested or exceed capacity for much of the day, **42%** during peak periods.



Source: Delcan.

# *Supply Chain Imperatives*

- Time is money: reduce transit and dwell time, cargo processing, virtual warehouses, trucking advantage
- Scale economies: Bigger ships and hub systems, warehouse/distribution centers, rail long-haul high-volume advantage
  - Drewry: 40% of ships arrive 1 or more days late for berthing windows
- Benchmarking and Standardization
- Wal-Mart (still) sets the standard
- Customer service still important
- Agile SC to respond to changes



# *Strongest forces driving decisions in logistics*

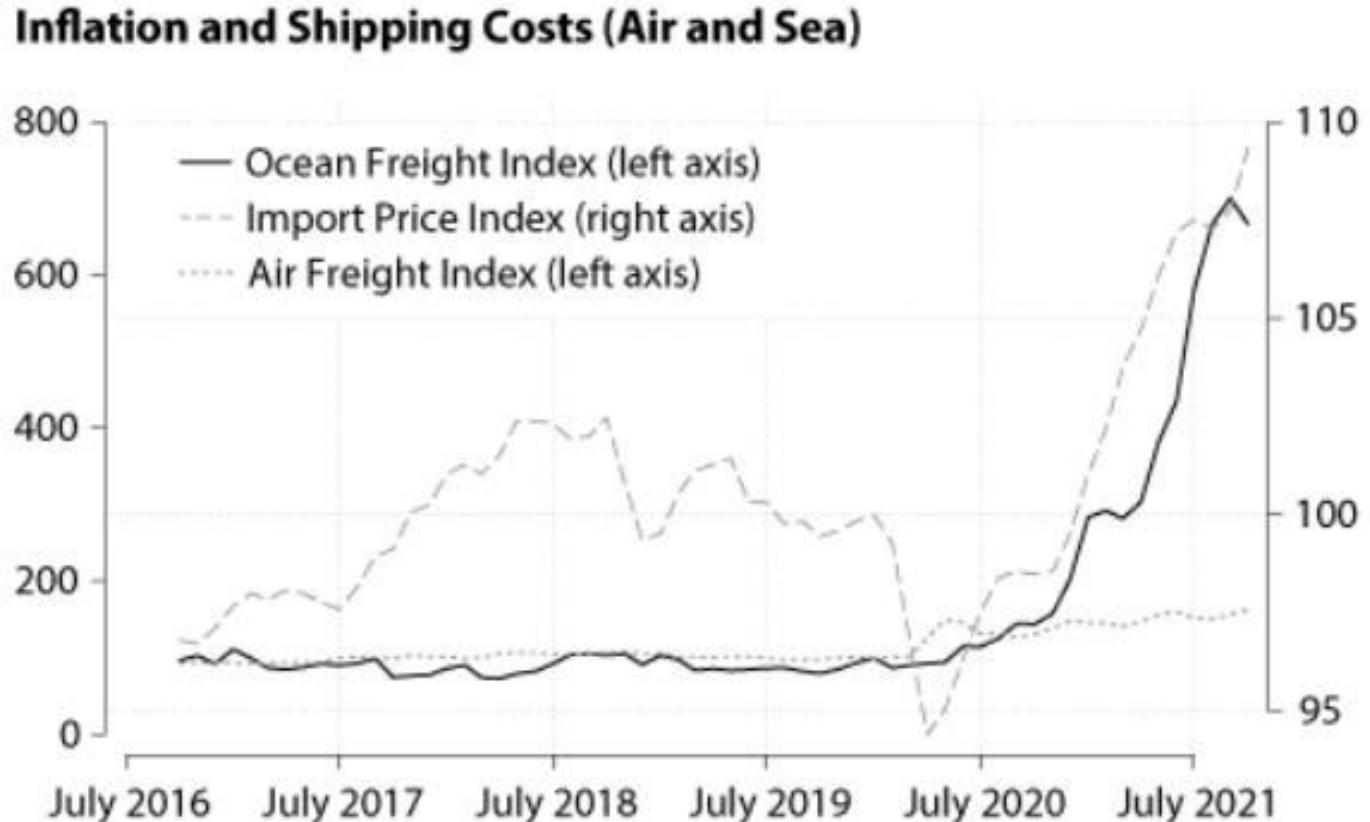


- Costs
- Service
- Cost and Service
- Declining/Changing Demand
- Process Simplification
- Technology
- Sustainability
- **Flexibility**

# *Transportation Choice Decision Factors: New Trends and Influences*

- Re-mix: Move from category to velocity-based distribution
- DSD: Direct store deliveries (DVDs, some apparel, etc.)
- Requires more ship, more capital and more fuel to run all water service: 5 ships to WCNA vs. 8 via Panama Canal
- 1 day of work stoppage in LA/LB = 1 week of delay
- Shipping companies to take more control of land-side services (partnerships with RRs as an example)
- Relationship between feeder service and transshipment ports, need bigger feeder ships as well

# *Trends on shipping cost*

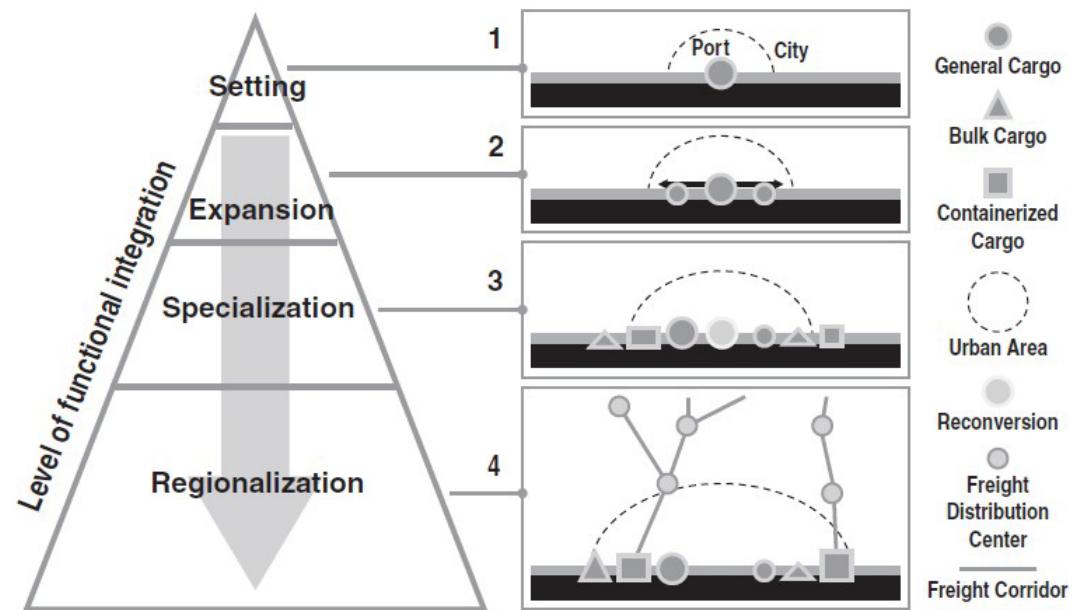


NOTE: The figure uses a monthly average [Freight Chain Index](#), an Import Price Index, and an Inbound Air Freight Price Index.

SOURCE: Freightos and FRED®, Federal Reserve Bank of St. Louis.

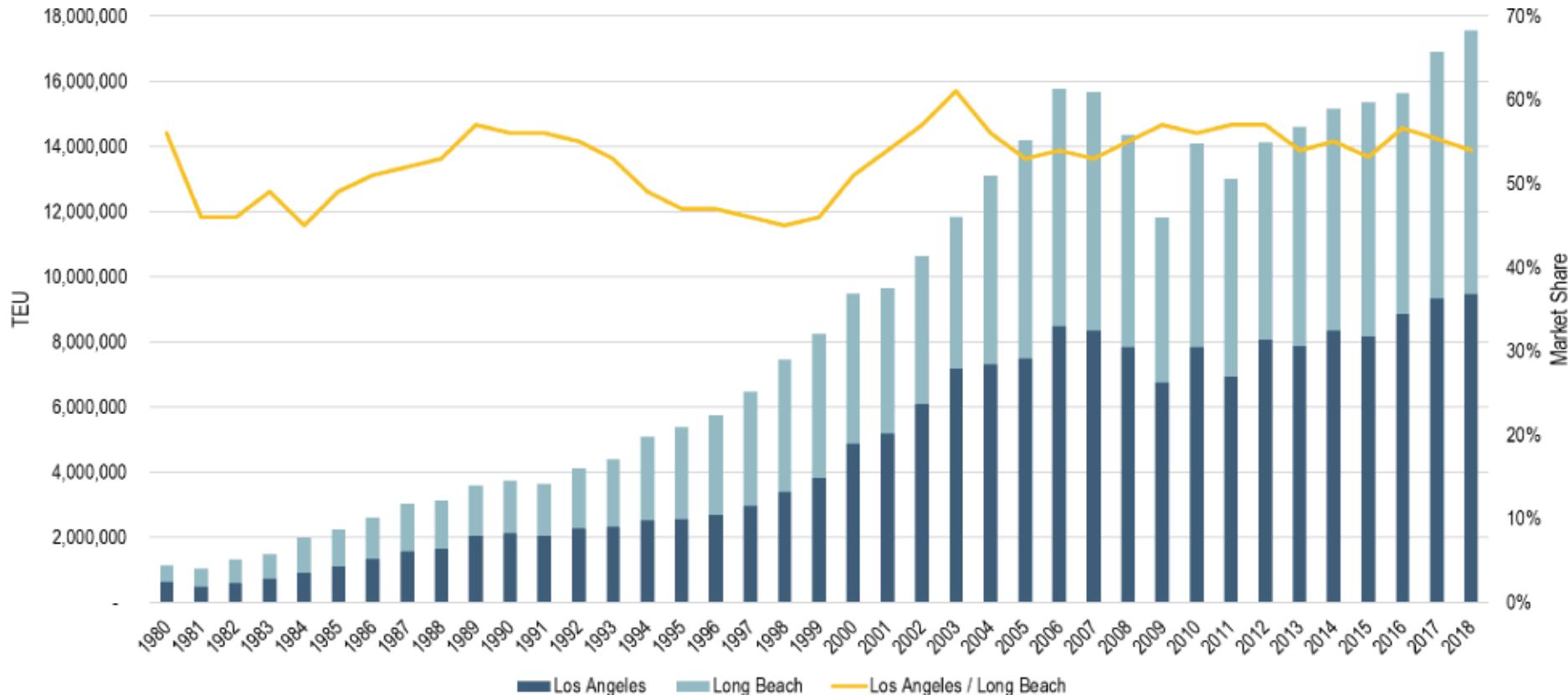
# *Ports have become regionalized hubs*

- Ports have a new functional role in value chains
- “Regionalization” of port network
  - Seaports and their inland terminals highly integrated
  - New patterns of freight distribution
  - Port hierarchy
- Changes in spatial configurations
  - Seaport function goes beyond the port beyond traditional perimeter
  - Inland distribution key success (exports/imports)



Theo E. Notteboom & Jean-Paul Rodrigue (2005) Port regionalization: towards a new phase in port development, Maritime Policy & Management, 32:3, 297-313, DOI: 10.1080/03088830500139885

# *Post Recession Volumes: Ports*



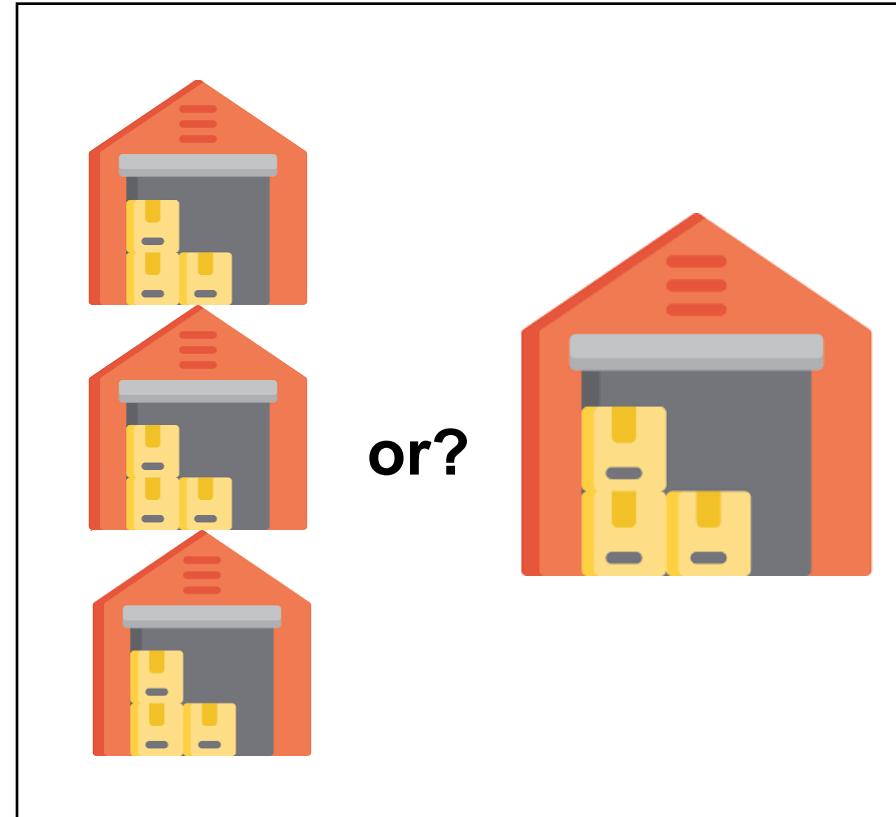
- They're back!
- LA/LB ports combined account for 32% **40%** of total container traffic in US

# *Trends: Warehousing*

- Warehousing moving closer to inland ports/Intermodal Terminals
  - Drayage costs, Railroad Service
- Increasing **flexibility** in supply chains
  - Diversified Port Strategies – increase activity for East Coast ports
  - Continually changing sources of supply
- Distribution Network Adjustments
  - New network rationalization
  - Deconsolidation centers as additions to network
- Development of **big box DCs**
  - DCs of 400,000 square feet or more account for 36.8% of all new warehouse construction in US since 2000.
- Growth of **direct-to-consumer sales** has forced major retailers to consolidate online and store-based fulfillment operations under one roof
- Increased use of **tech** like layer picking for simultaneous building of cases for different customers

# *What are the most recent changes in the logistics network?*

- Downsizing the Network
- Direct Shipping
- Increased Use of 3PLs
- New DC
- Nearshoring



# *What is the most recent change in support systems?*

ERP (forecasting, procurement)

WMS (location, picking, shipping)

TMS (dispatching, yard, tracking)



VISIBILITY



# *Trends in SCM Information Systems*

## *Example: Warehouse Management System*

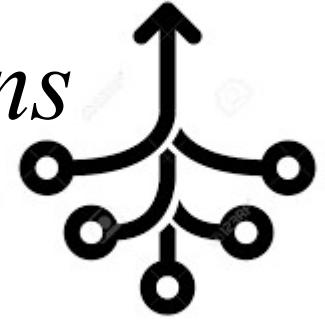


# *Five Levers for Effective Supply Chains*

**Mode mix:** Identifying the correct combination of transportation modes (road, rail, ocean, and air) for freight movements can increase the overall cost effectiveness of shipping activities.



# *Five Levers for Effective Supply Chains*



**Consolidation:** The second tool to consider, consolidation, has gained considerable interest as more companies utilize regional supply chains in order to increase flexibility. This can mean establishing operations in suitable locations to reduce the average distance needed to service regional operations, and at the same time consolidating and centralizing some processes (such as manufacturing and distribution) in favorable countries.

# *Five Levers for Effective Supply Chains*

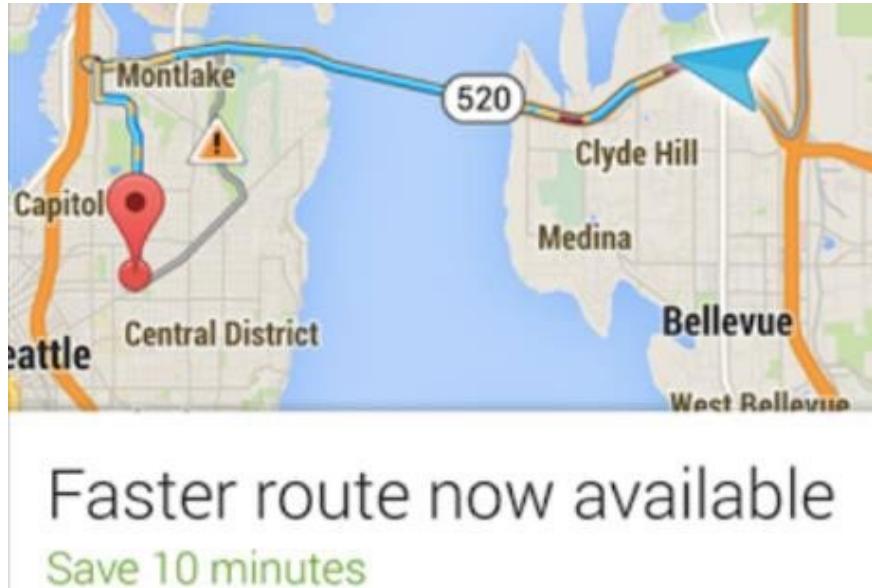
**Postponement:** Increased use of postponement strategies can reduce volatility in inventory and

shipment volume by delaying certain processes and completing them at later points in the supply chain.



Source: CSCMP's Supply Chain Quarterly 2/2011

# *Five Levers for Effective Supply Chains*



**Rerouting:** Changing the route of a particular supply chain leg can reduce transportation and inventory costs while increasing speed to market. The benefits of this relatively simple change can be substantial.

# *Five Levers for Effective Supply Chains*



**Rightshoring:** Involves taking total landed cost into consideration in order to determine the optimal location of distribution centers and plants for serving a particular market. Not only can rightshoring help companies reduce costs in certain cases, but it can also reduce supply chain complexity.

# Challenges to change

- Top management indifference
- Lack of internal company alignment & metrics
- Lack of data visibility
- Inadequate supply chain infrastructure
- Environment & climate issues
- Lack of a qualified labor pool
- Complex security issues

- Maritime rules & regulations
  - In US no obvious leadership for fundamental change within the supply chain
    - 17 agencies in 6 Cabinet-level depts. involved at federal level
    - 32 agencies involved in port planning at State level
  - IMO rules a suggestion, not law

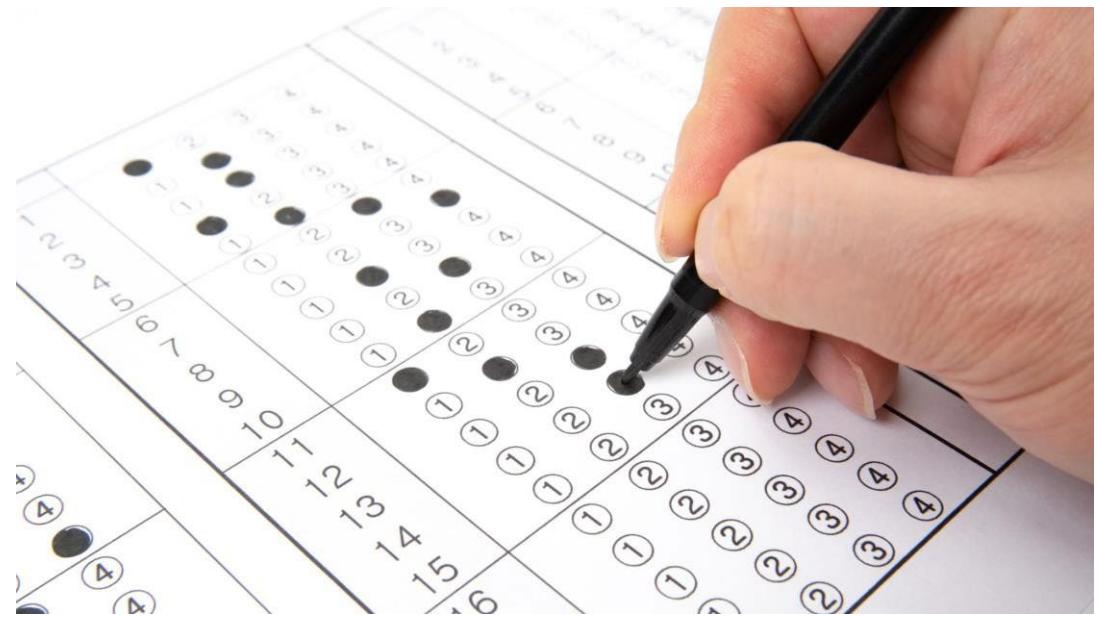
# *Assignment*

- Case 4 prerecorded presentation due before next class
  - Remember that presentation should be BRIEF (5-6 minutes)
  - Everyone participates some way, shape, or form
  - Q&A will follow

*Office hours! Last one 5/9, Tuesday from 1-2pm (or by appointment!)*

# *Final Exam*

- Starts at 8pm after presentations & quick break
- 1.5 hours + 15 minutes to post
- 100 points
- Review: slides, summary of learning objectives, homework and quiz answers



## **Exam is worth 100 points, 3 sections**

Section 1: T/F, multiple choice	10 Q at 2 pts/piece	similar to quizzes, based on concepts, but some might need a calculator
Section 2: Essay	1 question at 20 pts	the big picture, integration of several concepts (based on lecture/videos)
Section 3: Problems using Excel templates	3 questions at 20 pts/piece	LP
		FC + accuracy
		Agg planning or inventory management (pick 1 from 3 questions)

# *Final Exam*

Topic	Module/chapter	Types of questions
SC overview, drivers, & metrics	Module 1/ Chapter 1, 3	concepts
Forecasting, agg planning	Module 2/ Chapter 7, 8	<ul style="list-style-type: none"> <li>- concepts</li> <li>- develop FCs using various methods (naïve, weighted avg, moving avg, expo smoothing, linear), when to use method, FC error/accuracy (MAD, MSE, MAPE)</li> <li>- level and chase plan comparison</li> <li>- linear programming (Solver) to solve mix and constraint problems (set up, solve, report); ID objective function, constraints, feasible solution, slack, surplus</li> </ul>
Sourcing, sustainability	Module 3/ Chapter 15, 17	concepts
Inventory management, replenishment planning under certainty and uncertainty	Module 4/ Chapter 11, 12	<ul style="list-style-type: none"> <li>- concepts</li> <li>- SS, EOQ (TC), EPQ, quantity discounts, ROP (usage/LT constant, varying usage, varying LT)</li> </ul>
SCOR	Module 5	concepts
Network design	Module 6/ Chapter 4, 5, 6	concepts
Transportation, supply chain trends	Module 7/ Chapter 14	concepts, especially the Five Levers for driving supply chain efficiency

# *Final Exam Review*

