

CTL.SC1x -Supply Chain & Logistics Fundamentals

Fundamentals of Freight Transportation



MIT Center for
Transportation & Logistics

Agenda

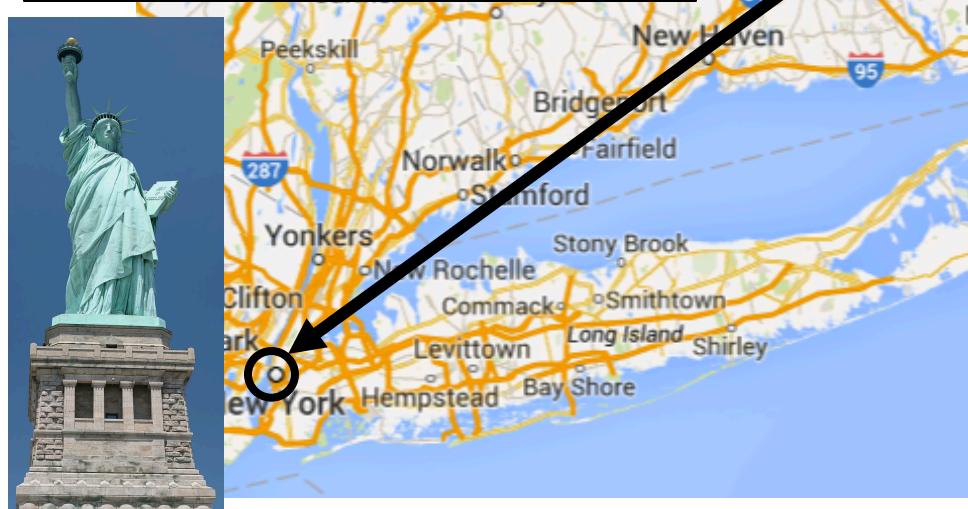
- Introduction to Freight Transportation
- Levels of Transportation Networks
 - Physical
 - Operational
 - Strategic / Service
- Connections to Inventory Planning

How do I get from Boston to New York City?



Modes of Transport

- Walking
- Bicycle
- Boat or Swim
- Taxi Cab
- Rental Car
- Privately Owned Vehicle
- Bus
- Air
- Train

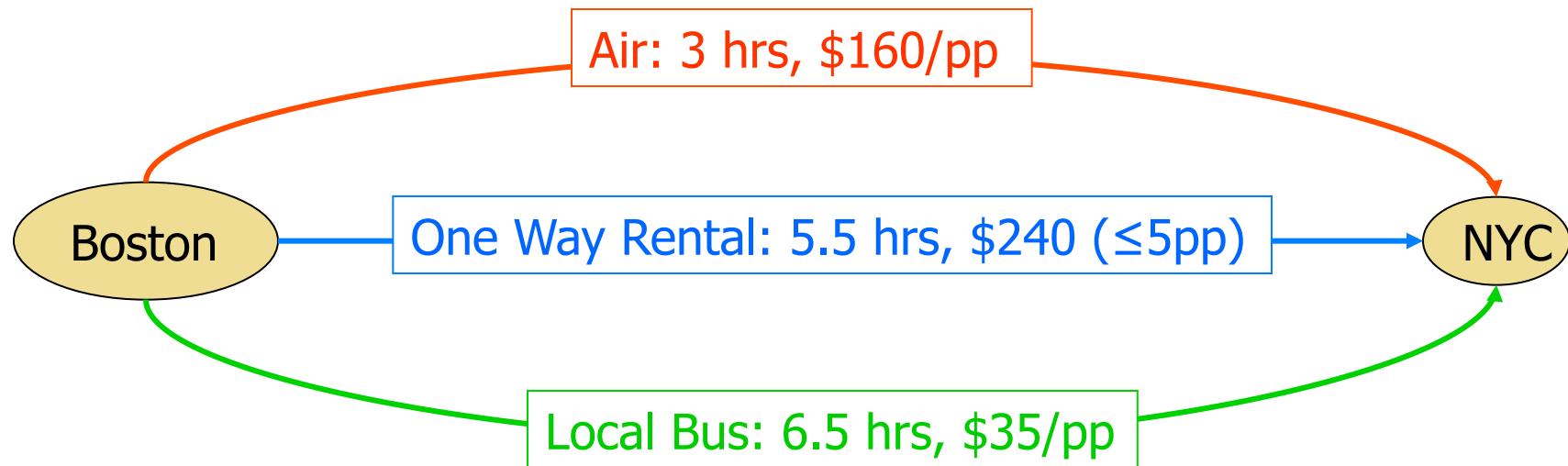


Metrics – Dimensions

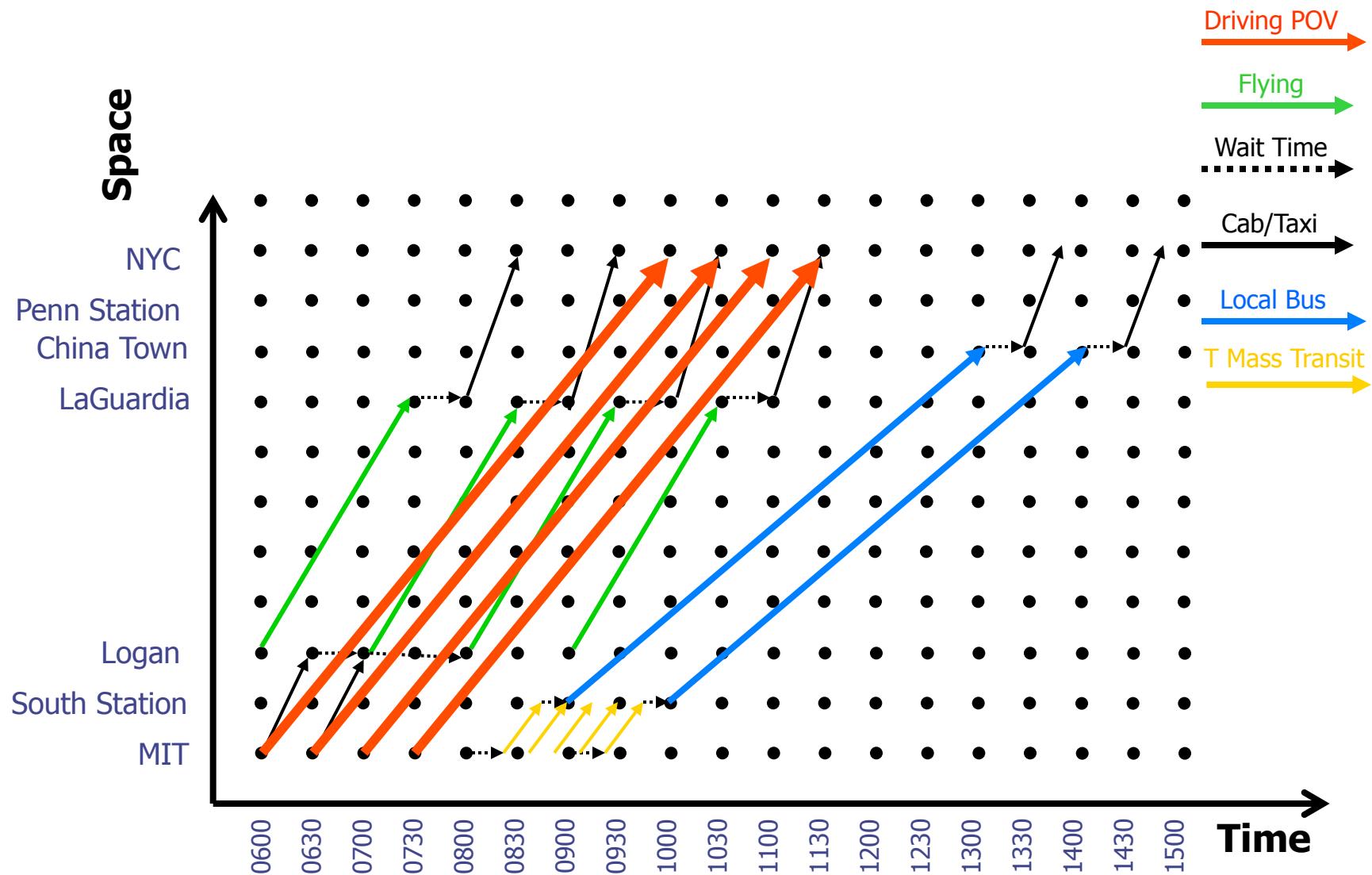
- Cost (variable, fixed, capital)
- Transit time (mean and variability)
- Reliability
- Consistency
- Frequency of delivery
- Capacity
- Comfort
- Safety
- Ease of Access

Route / Mode Selection

- Trade-offs between Cost and Level of Service (LOS)
- Path view of the Network
- Summarizes movement in common financial and performance terms
- Used for selecting one option from many by making trade-offs



Time Space Diagram



Passenger vs. Freight Transportation

- Similarities
 - ◆ Scheduled v. Direct Modes
 - ◆ Trade-offs between LOS and cost
 - ◆ Fundamental Activities Common
 - ◆ Contract Types imply Operational Use
 - ◆ Multiple Networks (Physical, Strategic, etc.)
- Differences
 - ◆ Quality of Time
 - ◆ Directional vs. Round Trips
 - ◆ Inventory Influences Decisions
 - ◆ Average length of Haul (ALOH)

Cases, Pallets, and Containers . . . oh my!

Packaging

Three levels of packaging:
Primary, Secondary, & Tertiary

Each serving different purposes



Primary Packaging

Packaging level mirrors handling needs

- "Eaches"
- Cases or Cartons
- Pallets (unitized or palletized loads)

Pallets

Standard size in United States
48 x 40 in. (~122 x 102 cm)



Euro-Pallet standard pallet in Europe
120 x 80 cm (~47 x 31 in)





Pallets



Shipping Containers



Characteristics

Airtight, Stackable, Lockable

International Sizes (8.5' x 8')

TEU (20 ft) Volume 33 M³

Total Payload 24.8 kkg

FEU (40 ft) Volume 67 M³

Total Payload 28.8 kkg

Domestic US (~9' x 8.25')

53 ft long Volume 111 M³

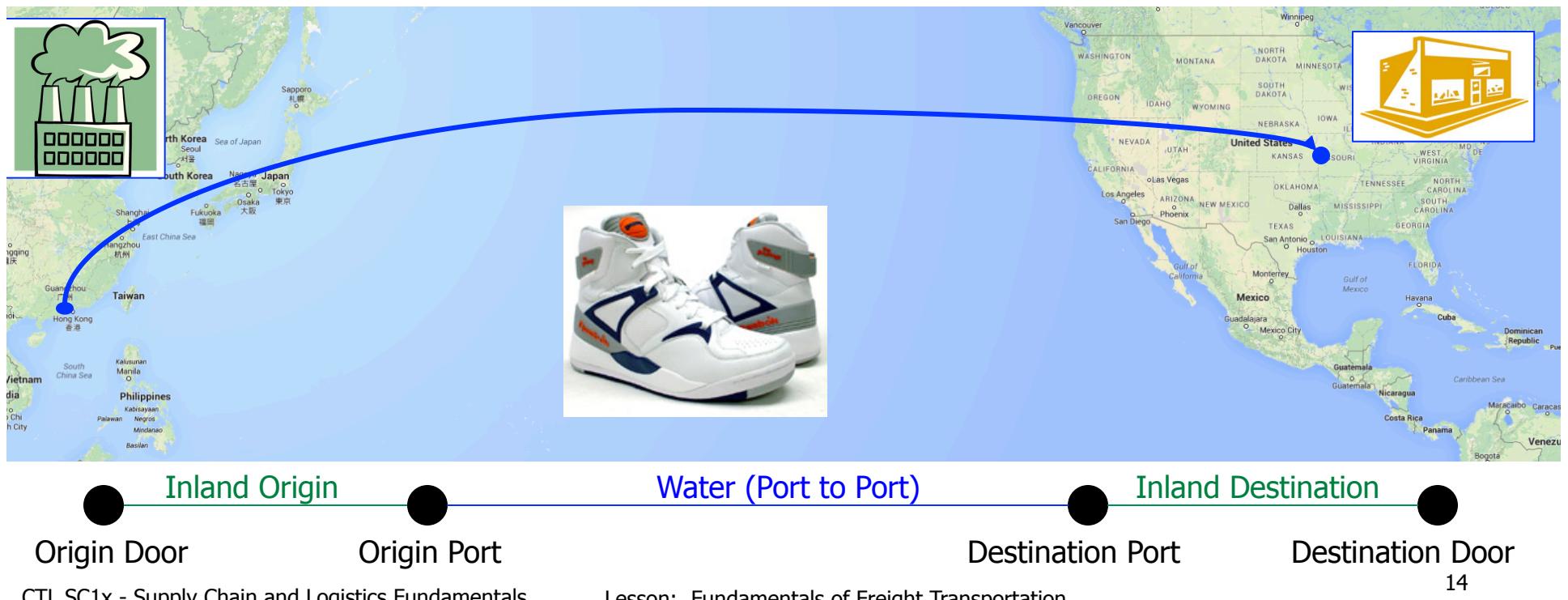
Total Payload 20.5 kkg



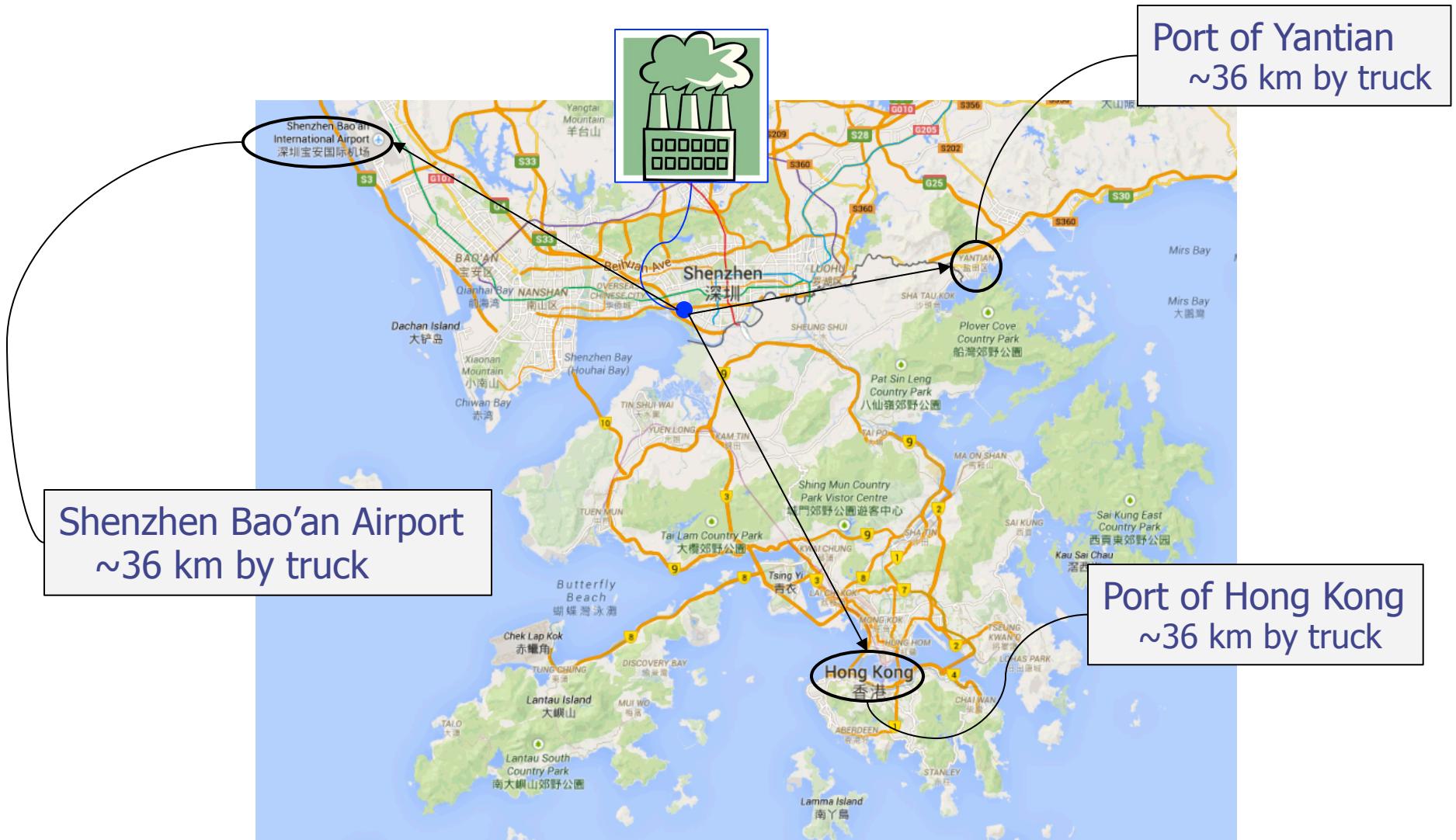
Shipping Shoes from Shenzhen

Shipping Shoes

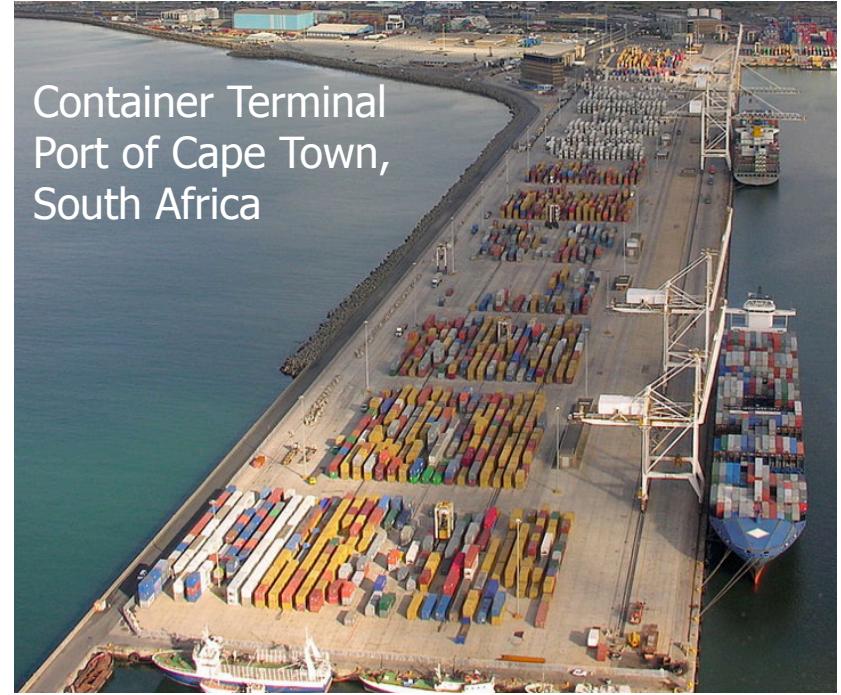
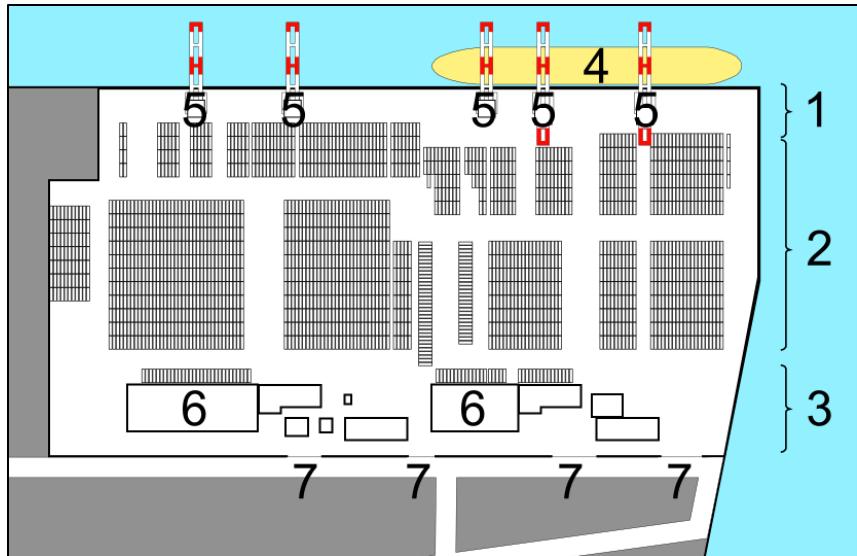
- ShoeCo manufactures and sells athletic shoes
 - Shoes are manufactured, labeled, and packed at plant in Shenzhen, China
 - ~4.5M shoes shipped per year from this plant
 - 3,000 shoes shipped per 20 foot (TEU) container
 - Value of pair of shoes ~\$35
 - Distribution center for North America is in Kansas City, USA
- What is the “best” way to ship my shoes Shenzhen to Kansas City?



Inland Transportation at Origin



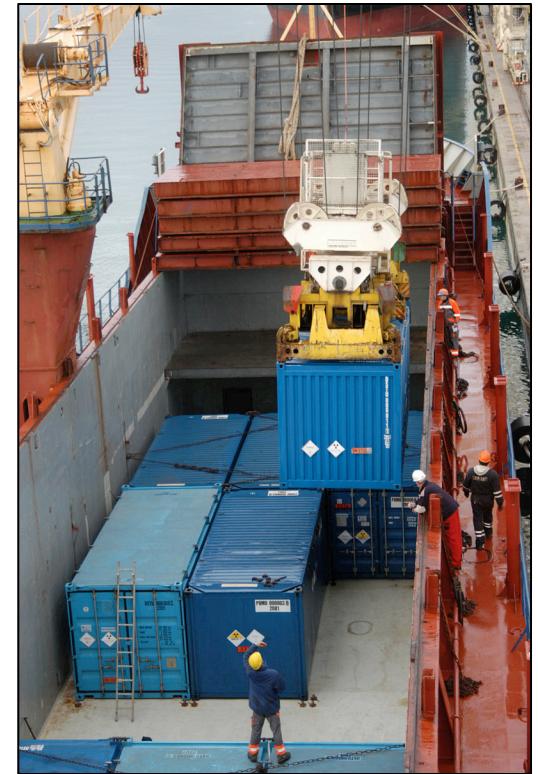
Container Terminals



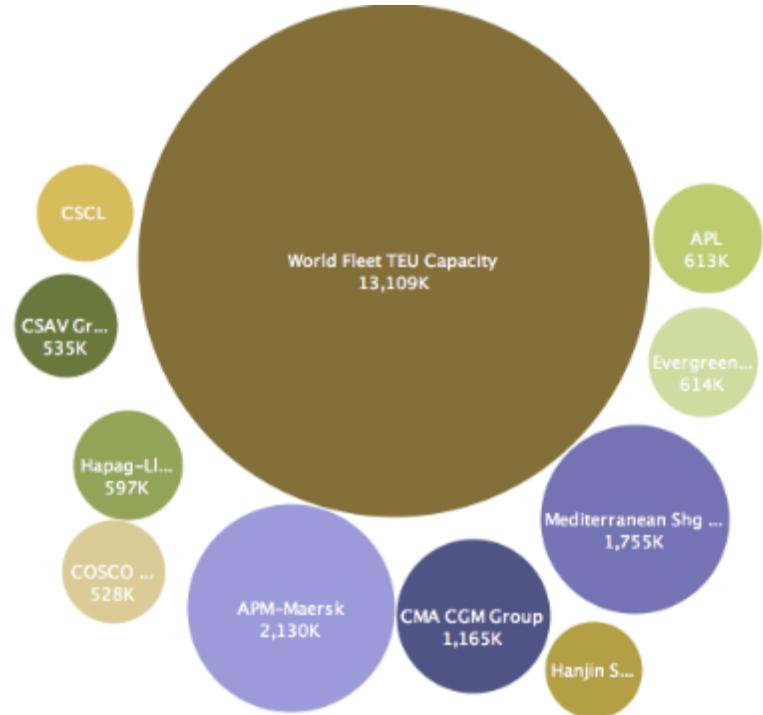
1. Apron Area
2. Container Yard
3. Gate Area
4. Ship
5. Gantry Cranes
6. Admin Bldgs
7. Gate



Loading/Unloading Containers



Container Ships

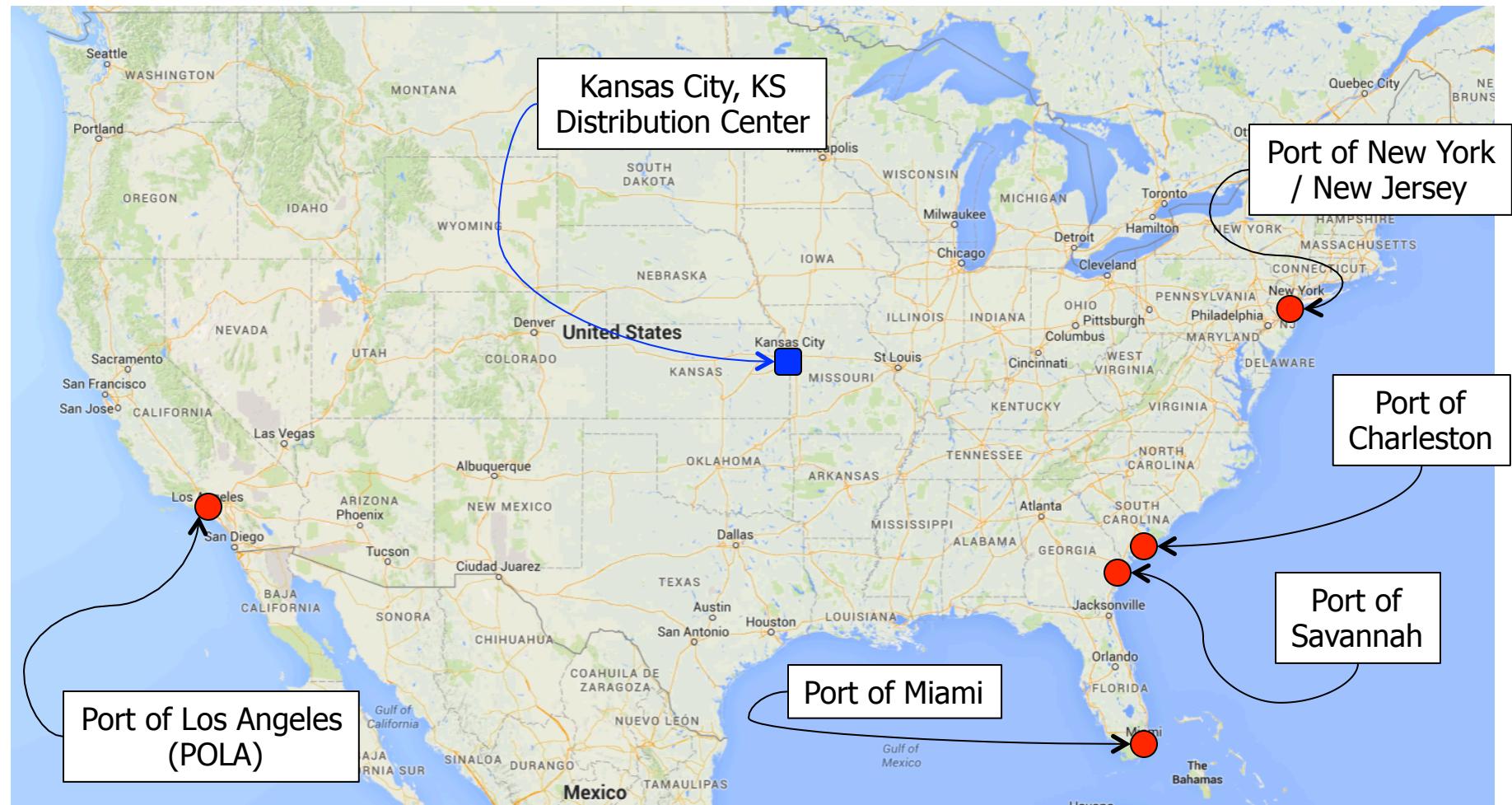


Ocean Shipping Options

- 40+ shipping lines visit these ports each w/ many options
- Examples:
 - APL – APX-Atlantic Pacific Express Service
 - ◆ Origins: Hong Kong (Sat) -> Kaohsiung, Pusan, Kobe, Tokyo
 - ◆ Stops: Miami (25 days), Savannah (27), Charleston (28), New York (30)
 - CSCL – American Asia Southloop
 - ◆ Origins: Yantian (Sat) -> Hong Kong, Pusan
 - ◆ Stops: Port of Los Angeles (16.5 days)

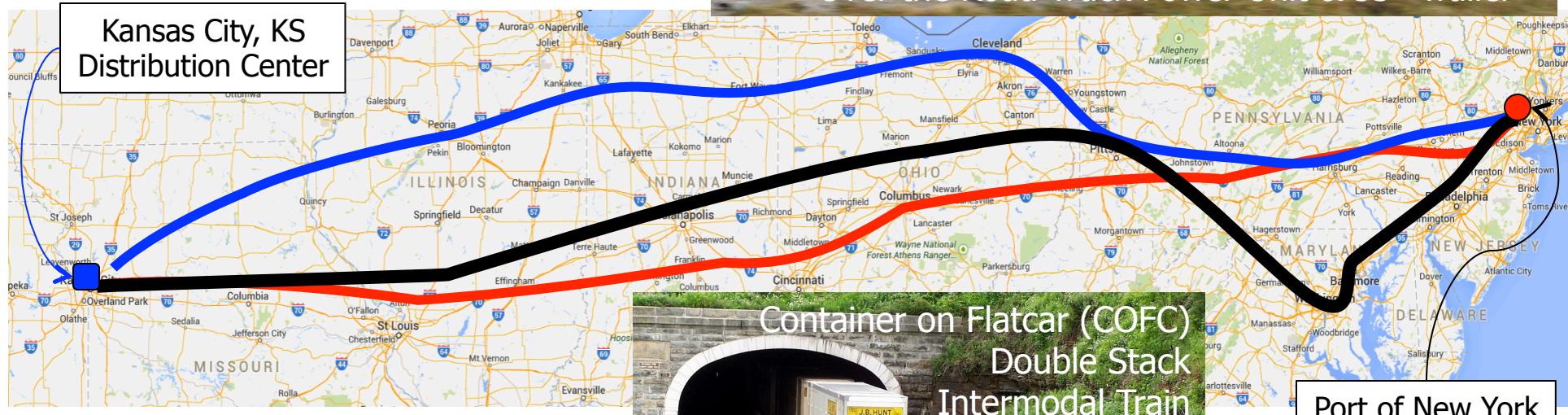


Inland Transportation at Destination



Inland Transport

Truckload (2.5 – 3 days)
NJ Turnpike to I-78W, I-76/70 to Kansas City



Express Rail II Norfolk Southern
Double stack thru: Harrisburg, Pittsburgh, Cleveland, Ft. Wayne, to Kansas City

CSX
Double stack thru: Philadelphia, Baltimore, Washington, Pittsburgh, Indianapolis, to Kansas City



Transit Times
TL: 2.5 - 3 days
Rail: 5 - 12 days

Also, Intermodal (IM)
requires truck to final
door (drayage)

Transport Options

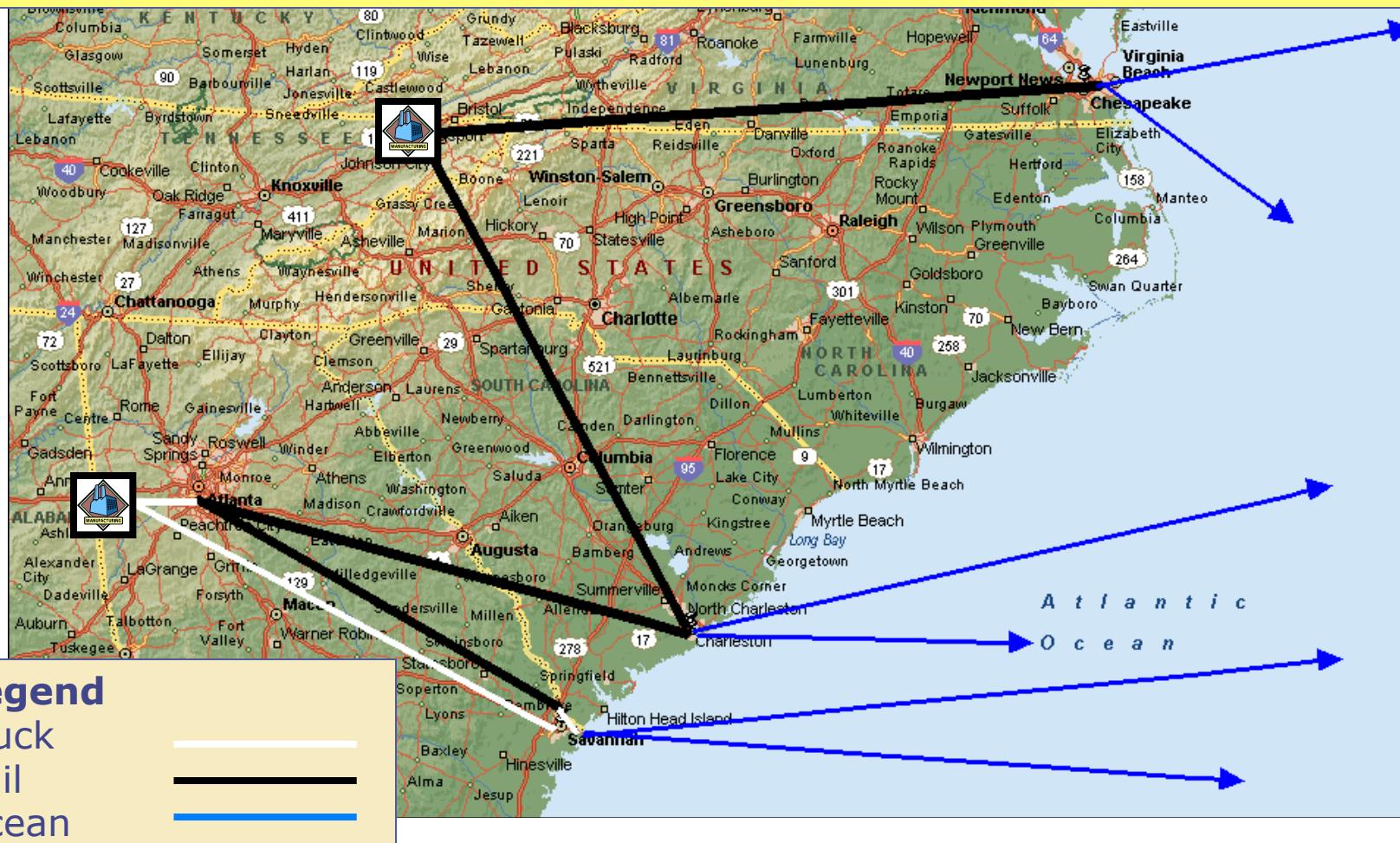
- How should I ship shoes from Shenzhen to Kansas City?
- Let's first consider different types of networks
 - Physical
 - Operational
 - Service/Strategic



Transportation Networks

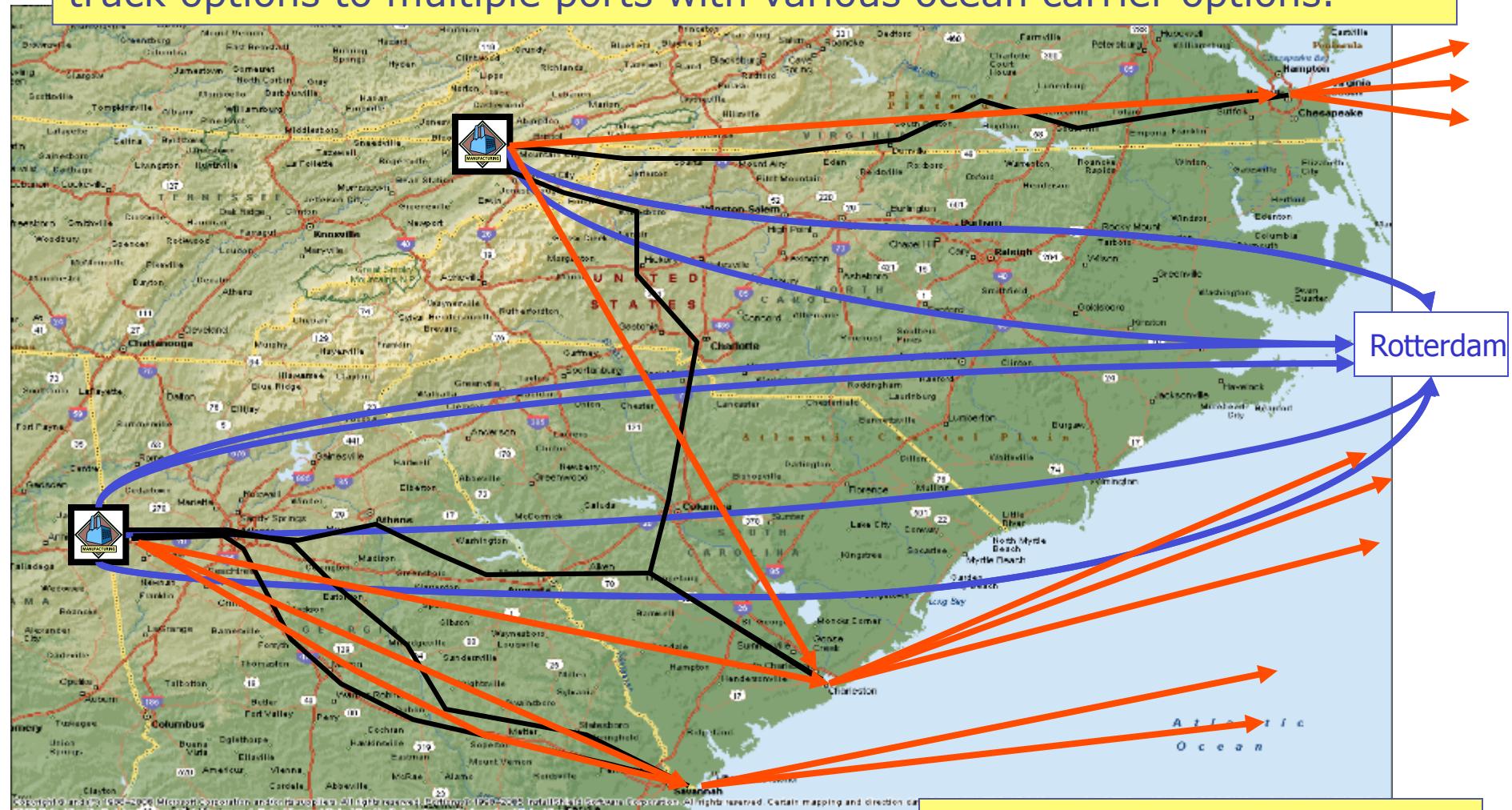
Transportation Networks

Example: Two clients ship product to Rotterdam. There are rail and truck options to multiple ports with various ocean carrier options.



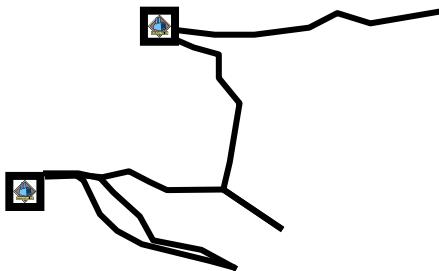
Transportation Networks

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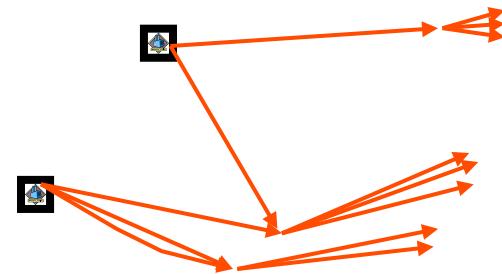
Physical Operational Strategic

Multiple Layers of Networks



Physical Network: The actual path that the product takes from origin to destination. Basis for all costs and distance calculations – typically only found once.

Operational Network: The route the shipment takes in terms of decision points. Each arc is a specific mode with costs, distance, etc. Each node is a decision point.



Strategic Network: A series of paths through the network from origin to destination. Each represents a complete option and has end to end cost, distance, and service characteristics.

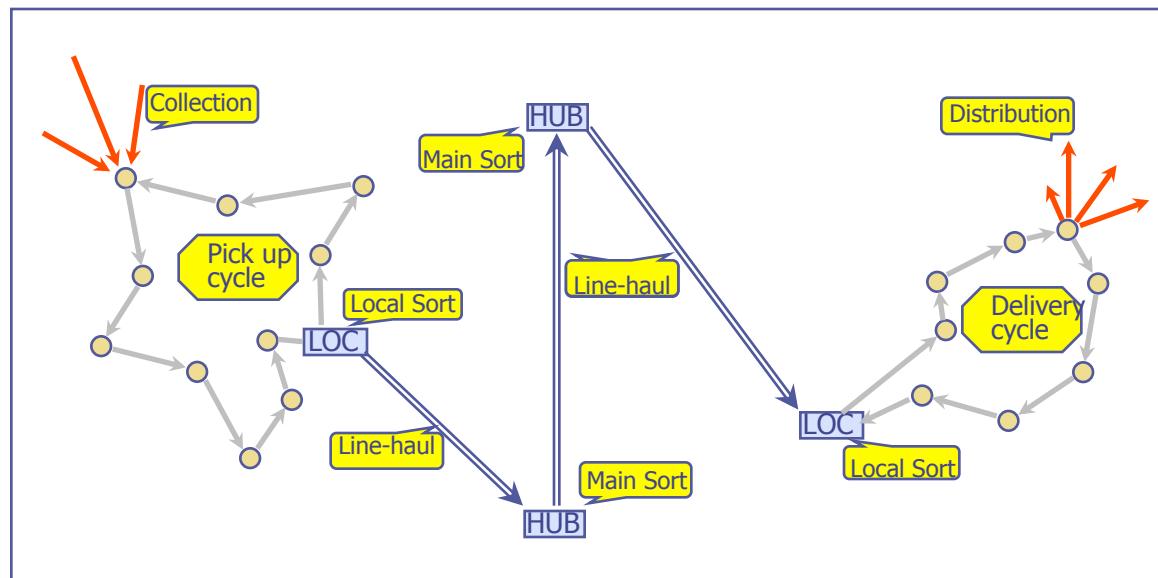
The Physical Network

- Guideway
 - Free (air, ocean, rivers)
 - Publicly built (roads)
 - Privately built (rails, pipelines)
- Terminals
 - Publicly built (ports, airports)
 - Privately built (trucking terminals, rail yards, private parts of ports and airports)
- Controls
 - Public (roads, air space, rivers)
 - Private (rail, pipelines)

The physical network is the primary differentiator between transportation systems in established versus remote locations.

Operational Network

- Four Primary Components
 - Loading/Unloading
 - Local-Routing (Vehicle Routing)
 - Line-Haul
 - Sorting



Source: Sheffi MIT-CTL

Node & Arc view of network
Each Node is a decision point

Strategic/Service Network

- Path view of the transportation network
- Used in establishing overall service standards for logistics system
- Summarizes movement in common financial and performance terms
 - used for trade-offs
- Interface into inventory and other planning



Example: Shipping Shoes Part 1.

Shipping Shoes Part 1.

How should I ship my shoes from Shenzhen to Kansas City?

- General Information

- Shoes are manufactured, labeled, and packed at plant
- Demand $\sim N(4.5M, 0.54M)$ annual demand
- 3,000 shoe boxes fit into one TEU
- Average cost $\sim \$35$ per pair
- Average sales price $\sim \$75$ per pair
- Order for shipment cost \$5000 per order
- Holding costs are 15%
- Assume 50 weeks/year, 350 days/year
- Assume CSL 95%

Which option provides the lowest transportation cost?

- Transportation Options

Inland Origin: Shenzhen to Ports (\$/container)

- Yantian (\$35, 2 day)
- Hong Kong (\$30, 5 days)

Port to Port: China to US (\$/container)

- CSCL (AAC) Yantian to POLA (\$1100, 20 days)
- CSCL (AAS) Hong Kong to POLA (\$1025, 13 days)
- APL Hong Kong to New York (\$1200, 29 days)

Destination Port: US Ports (\$/container)

- POLA (5 days)
- New York / New Jersey (3 days)

Inland Destination: To Kansas City (\$/container)

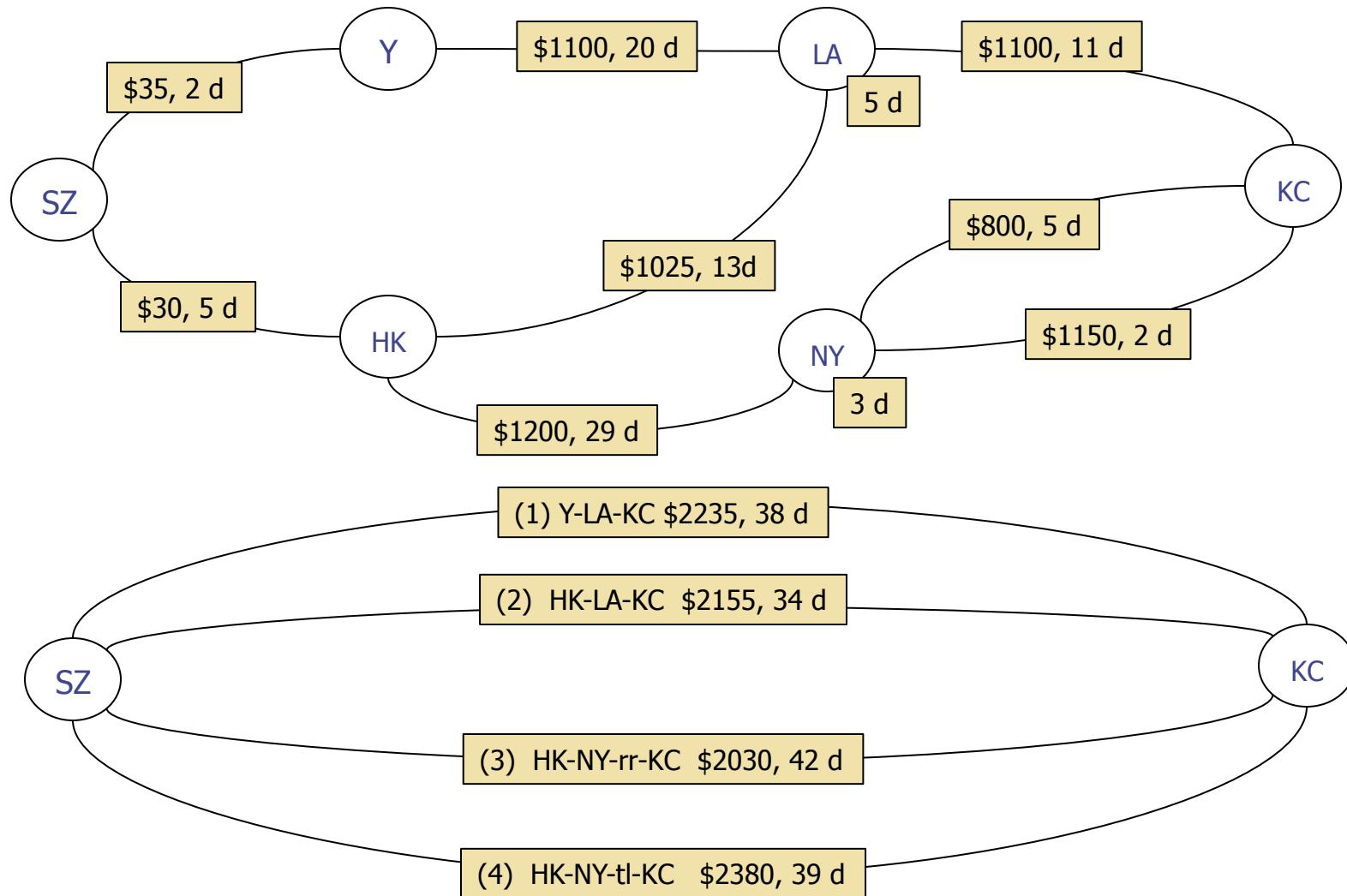
- POLA to KC by BNSF (\$1100, 11 days)
- PANYNJ to KC by NS (\$800, 5 days)
- PANYNJ to KC by HJBT Truckload (\$1150, 2 days)

Shipping Shoes Part 1 - Solution

- What do we know?
 - $D = 4,500,000$ pairs of shoes
 - $c_{\text{shoes}} = \$35$ per pair
 - $h = 0.15$ $\$/\$/\text{year}$
- Assume we ship full containers, how many?
 - Container capacity = 3,000 pairs/container
 - $4,500,000 / 3,000 = 1,500$ containers/year
- Which path has lowest transportation cost/container?

Shipping Shoes Part 1.

Values on arcs are cost per container



Lowest transportation cost path is (3) \$2030 /container = \$0.677 /pair of shoes

Key Points from Lesson

Key Points

- Transportation modes can be divided into:
 - Direct – move point to point as needed
 - Scheduled – move between terminals on schedule
- Direct modes need to be balanced
- Transportation systems are composed of multiple networks
 - Physical
 - Operational
 - Strategic / Service
- Mode and route selection is a trade-off:
 - Cost
 - Level of Service (LOS)
- LOS is multi-faceted and in the eye of the beholder

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Questions, Comments, Suggestions? Use the Discussion!



"Wilson" & "Dexter"
Yankee Golden Retriever Rescued Dogs
(www.ygrr.org)



MIT Center for
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caplice@mit.edu

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