

E216 Distribution and Transportation

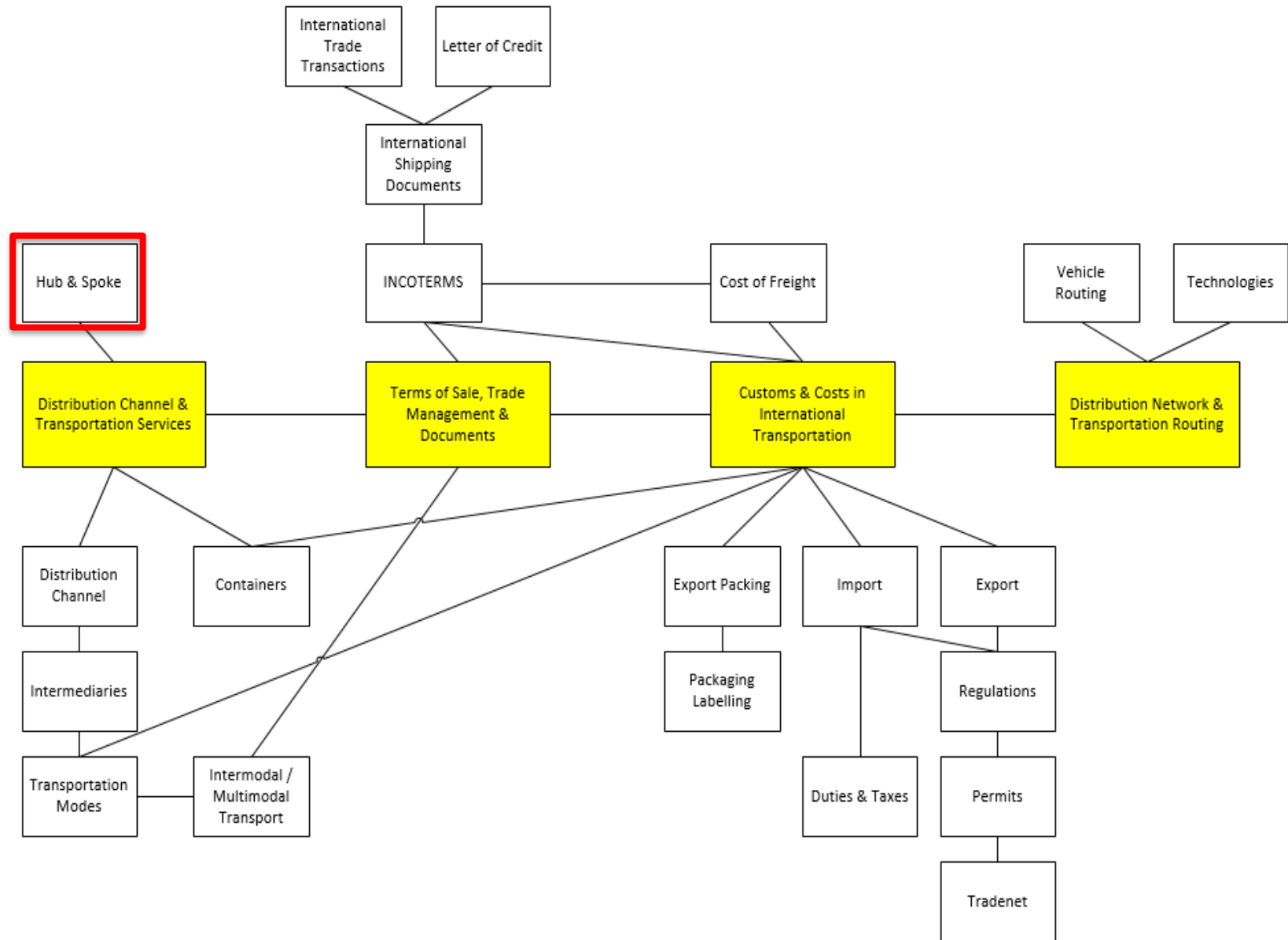
Problem 04

Select the Best Location



SCHOOL OF
ENGINEERING

E216 Distribution & transportation - Topic Tree



Definition of Terminals



- Any location where freight and passengers either originates, terminates, or are handled in the transportation process
- They may be points of interchange within the same modal system to ensure a continuity of the flows, particularly the case for airport and seaport operations
- Terminals are the key facilities in a Hub-and-Spoke System
 - Airports: Interface between air and land, between one airline and another
 - Seaport: Interface between sea and land, between one shipping line and another
 - Railway Station: Interface between rail and bus/taxi/walking
 - Bus Interchange: Interface between bus and taxi/walking

Functions of Freight Terminals



1. Pickup and Delivery (PUD)

- Basic transportation service is the pickup and/or delivery of freight on peddle runs
- Peddle run is a route out of the terminal for the purpose of collecting freight for outbound moves or delivering freight from inbound moves

2. Break-bulk

- Performs both consolidation and dispersion services

3. Relay

- Freight is not touched, but relay may be necessitated by transport regulations (usually for motor carriers)

Function of Seaport & Airport



1. Traffic handling – two categories:

- a. Import and export (cargo) or inbound and outbound – intermodal gateway between sea (air) and land
- b. Transshipment (cargo) or transit traffic – connection point between one ship (airline) and another

2. Unforeseen technical and emergency stops

3. Base for parking – ships and aircrafts

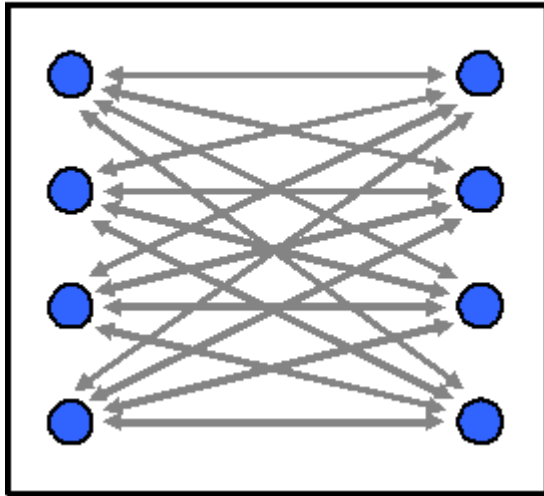
4. Ship (Aircraft) servicing centre – food, fuel and maintenance



Hub-and-Spoke

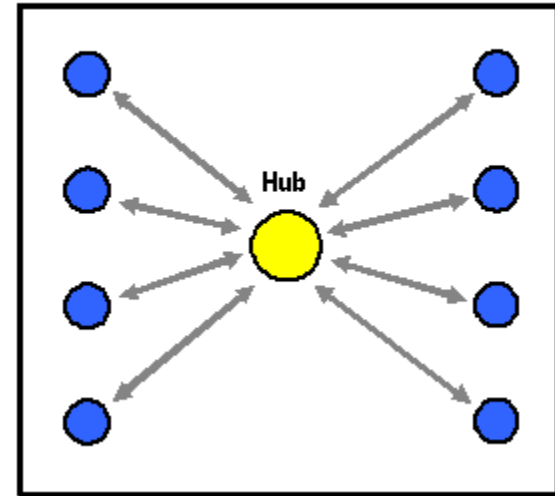


Point-to-Point



Cost of all point-to-point trips =
 $\$20,000 \times 32 = \$640,000$

Hub-and-Spoke



Cost of all point-to-point trips =
 $\$20,000 \times 16 = \$320,000$

- **Cost savings** from the reduction in trips (from \$640K to \$320K)
- **More passengers/cargoes per trip** due to aggregation from several cities at the hub- better utilization of transport

Pros & Cons of Hub-and-Spoke



Advantages

- Economies of scale on connections by offering a high frequency of services
- Economies of scale at the hubs, enabling the potential development of an efficient distribution system since the hubs handle larger quantities of traffic
- Economies of scope in the use of shared transshipment facilities rather than many minimal facilities in many small terminals

Disadvantages

- Additional transshipment as less point-to-point services are offered, which for some connections may involve delays
- Potential congestion as the hub becomes the major point of transshipment



TERMINAL AS A HUB



- A hub in this case is the central airport that are routed to, and spokes are the routes that planes take into/out the hub (Singapore Changi Airport).

TERMINAL AS A HUB



- International terminal (airport or seaport) – three kinds of traffic:
 - inbound (import)
 - outbound (export) and
 - transit (transshipment)
- Major seaport or airport terminal should cater to all three groups if it wants to be a global or regional hub
- **Hubbing** – focus on transit or transshipment traffic
- Key hubbing agents are **Carriers** (shipping lines and airlines) and **Freight Forwarders (FF)**

TERMINAL AS A HUB



Carriers (Airlines or Shipping Lines)

- A large containership / airline may stop at a few big ports along the way like Dubai, Colombo, Singapore, and Shenzhen, but it also sells cargo space to ports **outside this served network**
- The two ships may belong to the **same company** or **two different companies with an alliance agreement**
- Large container ships on routes stopping at major hubs – **mother vessels**. Small ships out of hubs to smaller ports – **feeder vessels**. In case of airlines, they are termed **trunk and feeder services**



TERMINAL AS A HUB



Freight Forwarders (FF)

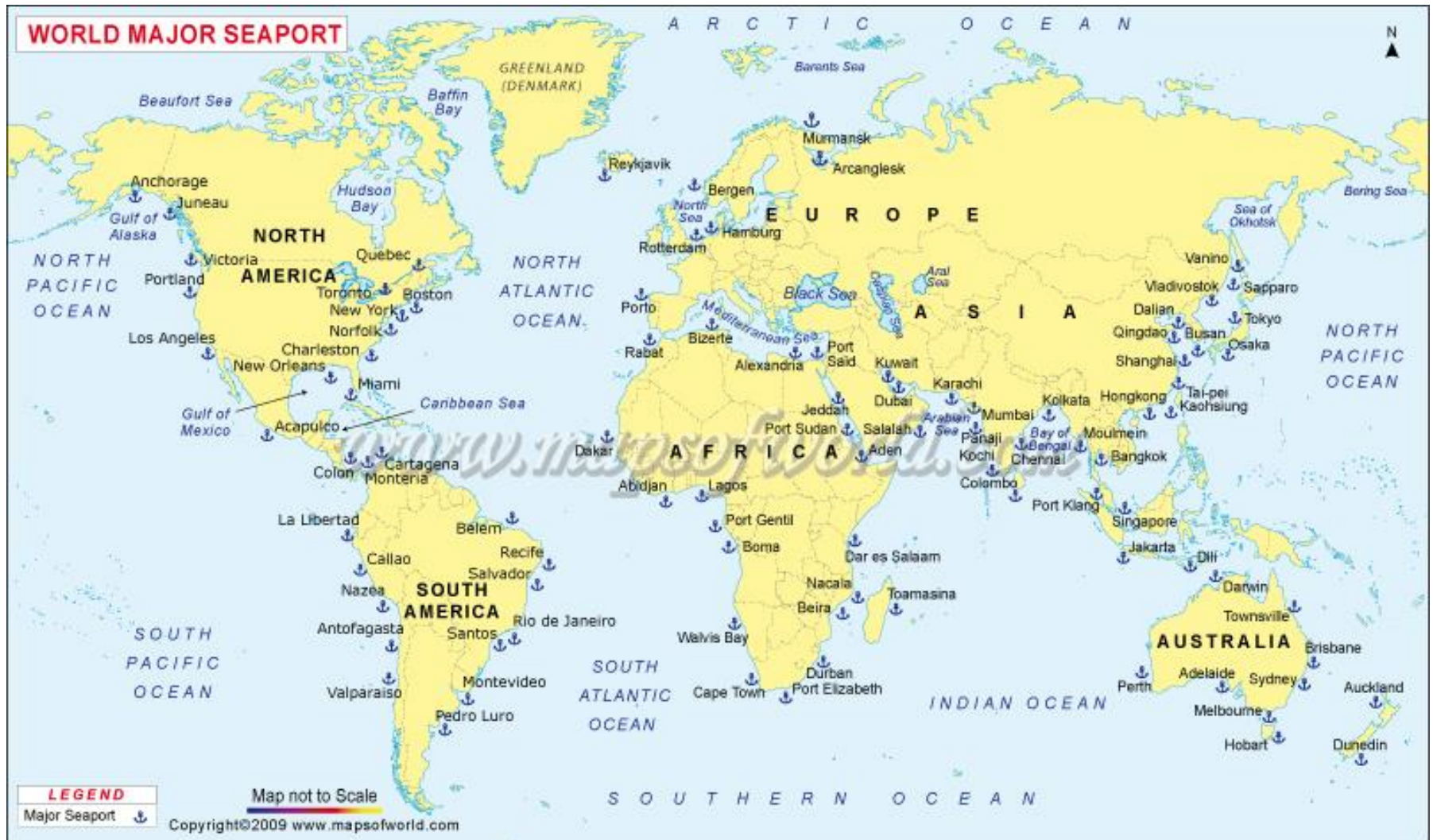
- Freight forwarders (FF) consolidate cargo for multiple destinations and sent to the shipping hub
- At the hub, the container is unloaded from the ship and reconsolidated according to destinations
- The **reconsolidated** containers are then sent back to the port to be put on the relevant ships going to these destinations



Major Air Hubs and Routes of the World



Major Sea Hubs of the World



Air Freedom Rights



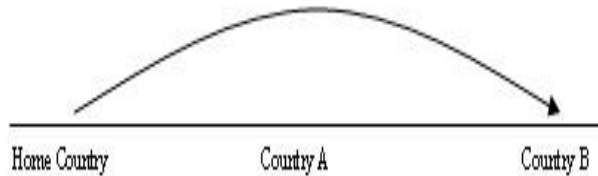
- A set of commercial aviation rights granting a country's airline(s) the privilege to enter and land in another country's airspace
 - After deregulation of the airline industry, the emergence of local hub-and-spoke networks centered on major airport where a single airline is often dominant
 - As airlines become more dependent on longer-haul international markets, in 1944, an International Convention was held in Chicago to establish the framework for all future bilateral and multilateral agreements for the use of international air spaces
- 9 Freedom of Air Passage

International Aviation Control



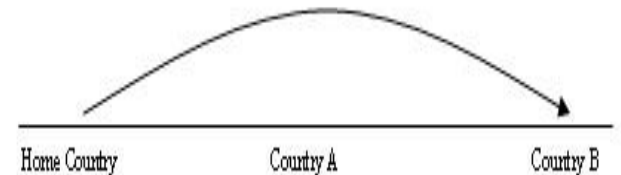
1st Freedom of air passage

Right for Home Country to fly over Country A



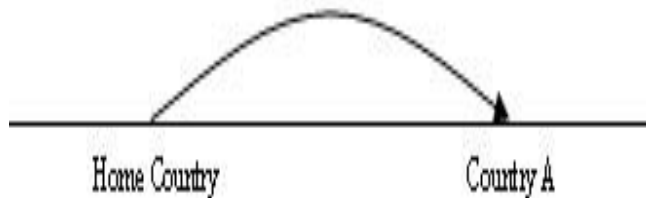
2nd Freedom of air passage

Right for Home Country to make technical stop in Country A



3rd Freedom of air passage

Right for Home Country to carry traffic to Country A

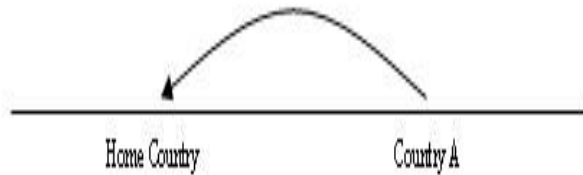


International Aviation Control



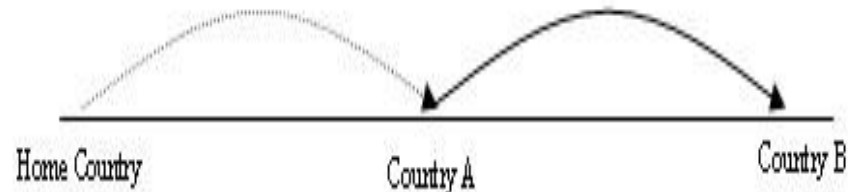
4th Freedom of air passage

Right for Home Country to carry traffic from Country A



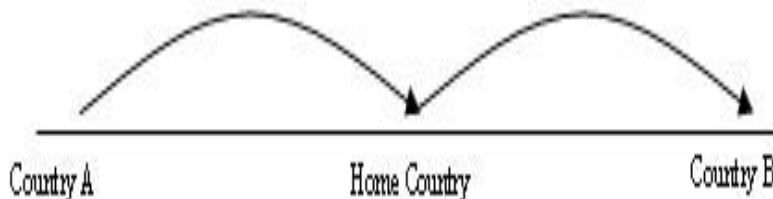
5th Freedom of air passage

Right for Home Country to pick up traffic in Country A and carry to other country



6th Freedom of air passage

Right for Home Country to carry traffic from foreign country to other country via its own territory

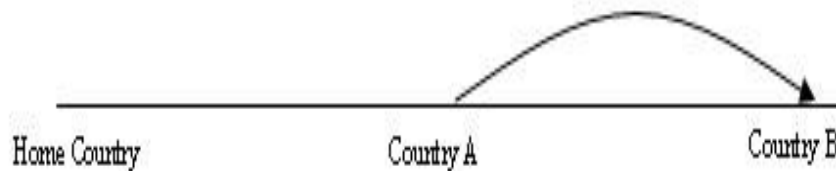


International Aviation Control



7th Freedom of air passage

Pure foreign flight: Right for Home Country to carry traffic from foreign country to another country



8th Freedom of air passage

Cabotage: Right for Home Country to carry traffic from City A in foreign country to another city in that country. Flight must originate in Home Country

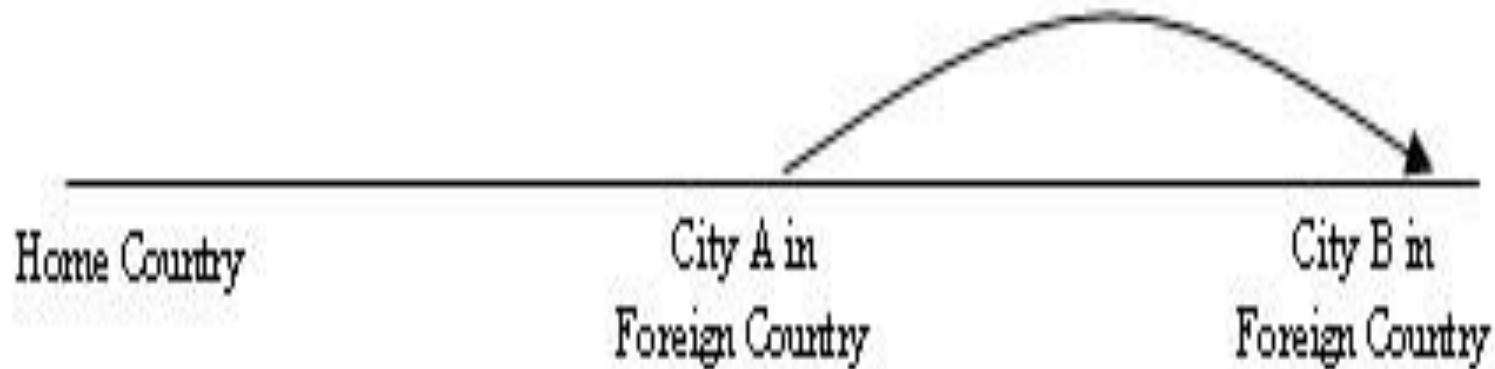


International Aviation Control



9th Freedom of air passage

Pure Cabotage: Right for Home Country to carry traffic from City A in foreign country to City B in same country. Flight need not originate in Home country



Importance of Location Analysis



- Gives structure to the entire network
- Significantly affects inventory & transportation costs
- Impacts on the customer service level
- Deciding on the various points (or nodes)

Source points
(e.g. Plants, ports, vendors)



Intermediate points
(e.g. Warehouses, Terminals, Service Centers)



Sink points
(e.g. Retail outlets, customers)



Classifications of Facilities



Types of Facilities

Heavy Industry Facilities

- Large, require a lot of space, and are expensive
- e.g. automobile plants, oil refineries, aviation parts



Light Industry Facilities

- Smaller, cleaner plants and usually less costly
- e.g. electronic components, pharmaceutical firms



Retail and Service Facilities

- Smallest and least costly
- e.g. department stores, banks, restaurants, clinics



Factors for Heavy & Light-Industry Facility



Heavy-Industry Facility

- Construction costs
- Land costs
- Raw material and finished goods shipment modes
- Proximity to raw materials
- Utilities
- Means of waste disposal
- Labor availability

Decisions are driven by **Cost Minimization**



Light-Industry Facility

- Transportation costs
- Proximity to Markets
- Frequency of delivery required by customer
- Land costs
- Accessibility

Decisions are driven by **Revenue Maximization**



Factors for Retail & Service facility

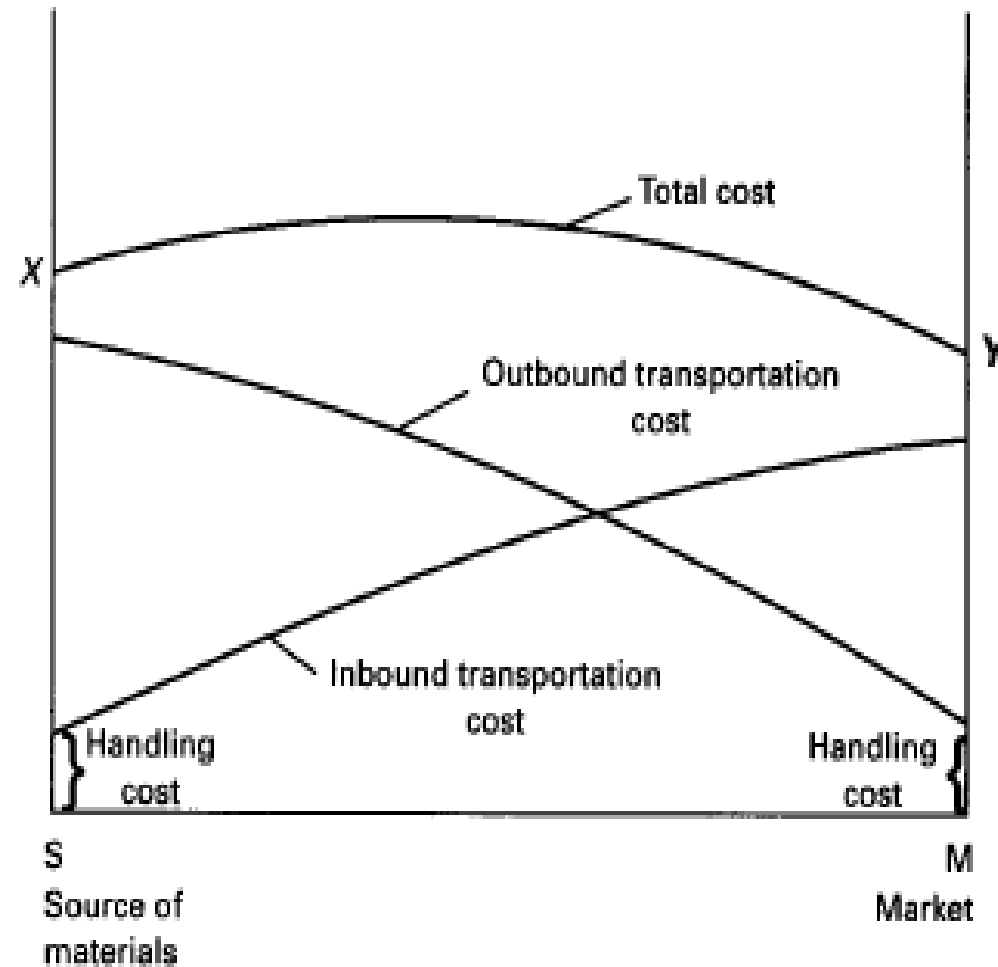


- Proximity to Customers
- High traffic flow and accessibility
- “Location is Everything”

Decisions are driven by **Service Factors**

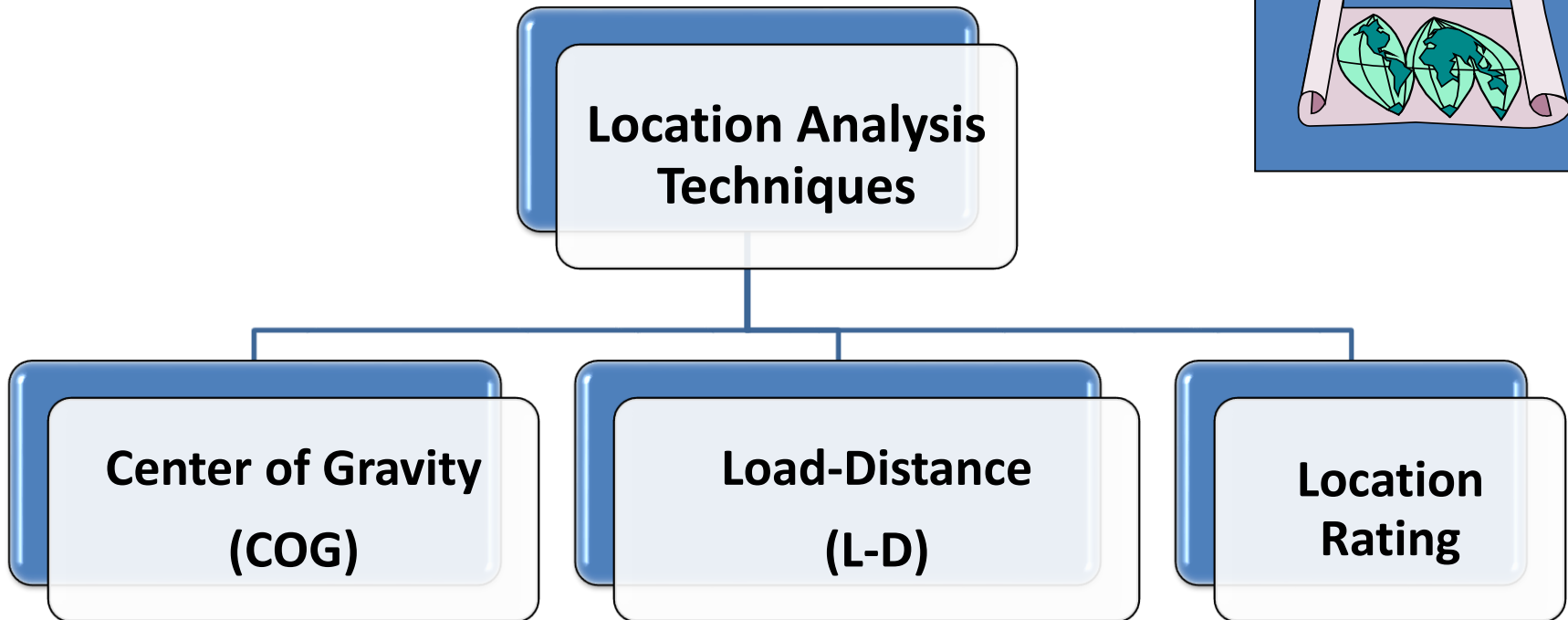
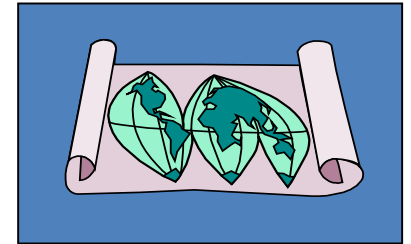


Hoover's Model



- Hoover considered both **cost** and **demand** elements
- Stressed **cost minimization** in determining an optimal location
- Hoover identified that **transportation rates & distance were not linearly related**

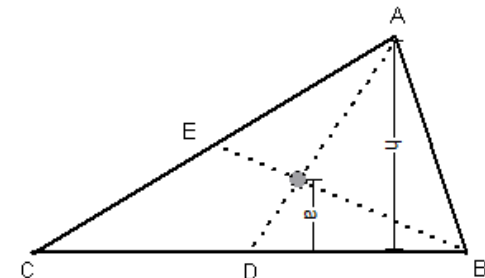
Location Analysis Techniques



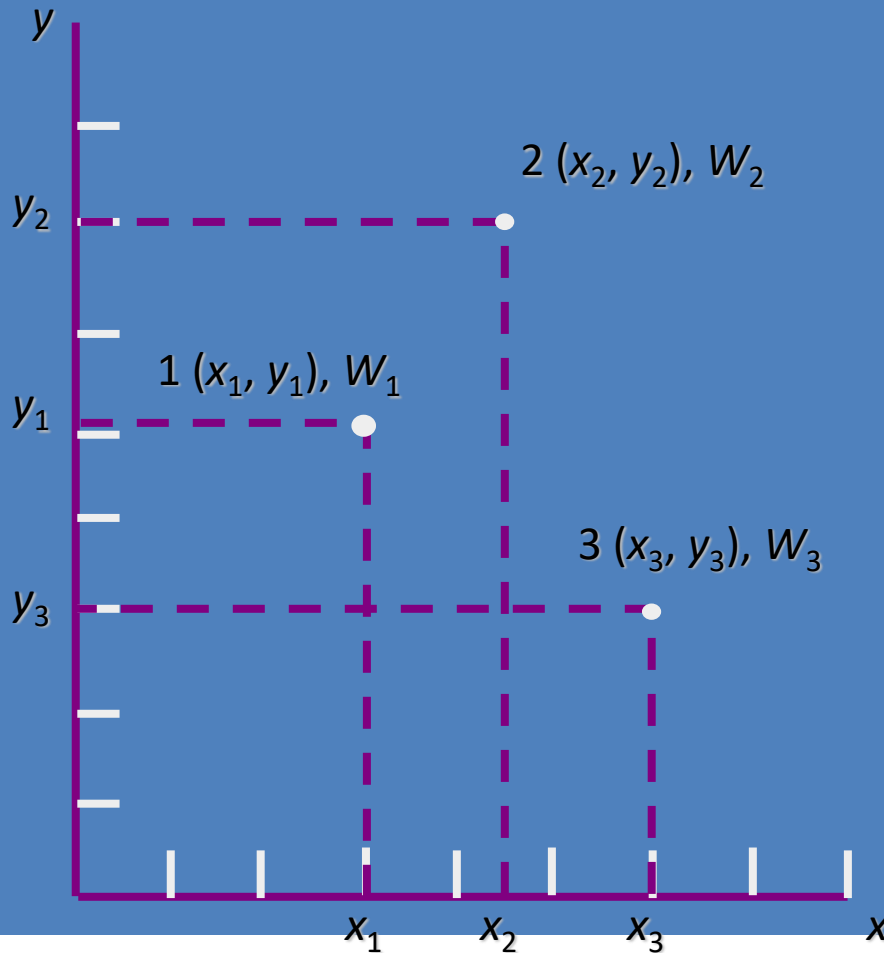
Centre-of-Gravity (COG)



- This approach locates a distribution centre at a point that minimizes transportation costs for products moving between a manufacturing plant and the markets
- Steps for computation
 - Locate facility at center of geographic area
 - Based on weight (costs) and distance travelled, establish grid-map of area
 - Identify coordinates and weights shipped for each location



Grid-Map Coordinates



$$x = \frac{\sum_{i=1}^n x_i W_i}{\sum_{i=1}^n W_i} \quad y = \frac{\sum_{i=1}^n y_i W_i}{\sum_{i=1}^n W_i}$$

where,

x, y = coordinates of new facility at center of gravity
 x_i, y_i = coordinates of existing facility i
 W_i = annual weight (costs) shipped from facility i

Load-Distance (L-D) Method



- A variation of the COG method, where various locations are evaluated using a load-distance value that is a measure of weight & distance
- Steps for computation
 - Compute (Load x Distance) for each site
 - Choose site with lowest (Load x Distance)
 - Distance can be actual or straight-line

Load-Distance Calculations



$$LD = \sum_{i=1}^n l_i d_i$$

where,

LD = load-distance value

l_i = load expressed as a weight, number of trips or units
being shipped from proposed site and location i

d_i = distance between proposed site and location i

$$d_i = [(x_i - x)^2 + (y_i - y)^2]^{1/2}$$

where,

(x, y) = coordinates of proposed site

(x_i, y_i) = coordinates of existing facility

Location Factor Rating



- Factors that are important in the location decision are identified
- Each factor is weighted from **0 to 1.00** to prioritize the factor and reflect its importance; total factor weights = 1.00
- A subjective score is assigned (usually between 0 & 100) to each factor based on its attractiveness compared with other locations, and the weighted scores are summed

Today's Problem (Task 1)



- John may consider adopting a Hub-and-Spoke model for ABC Furniture Pte Ltd distribution so as to enjoy:
 - Higher **economies of scale** AND
 - More **efficient routing**
- He needs to be aware of the **International Air Freedom Rights** when making transportation decisions with regards to air-freight

Today's Problem (Task 1)

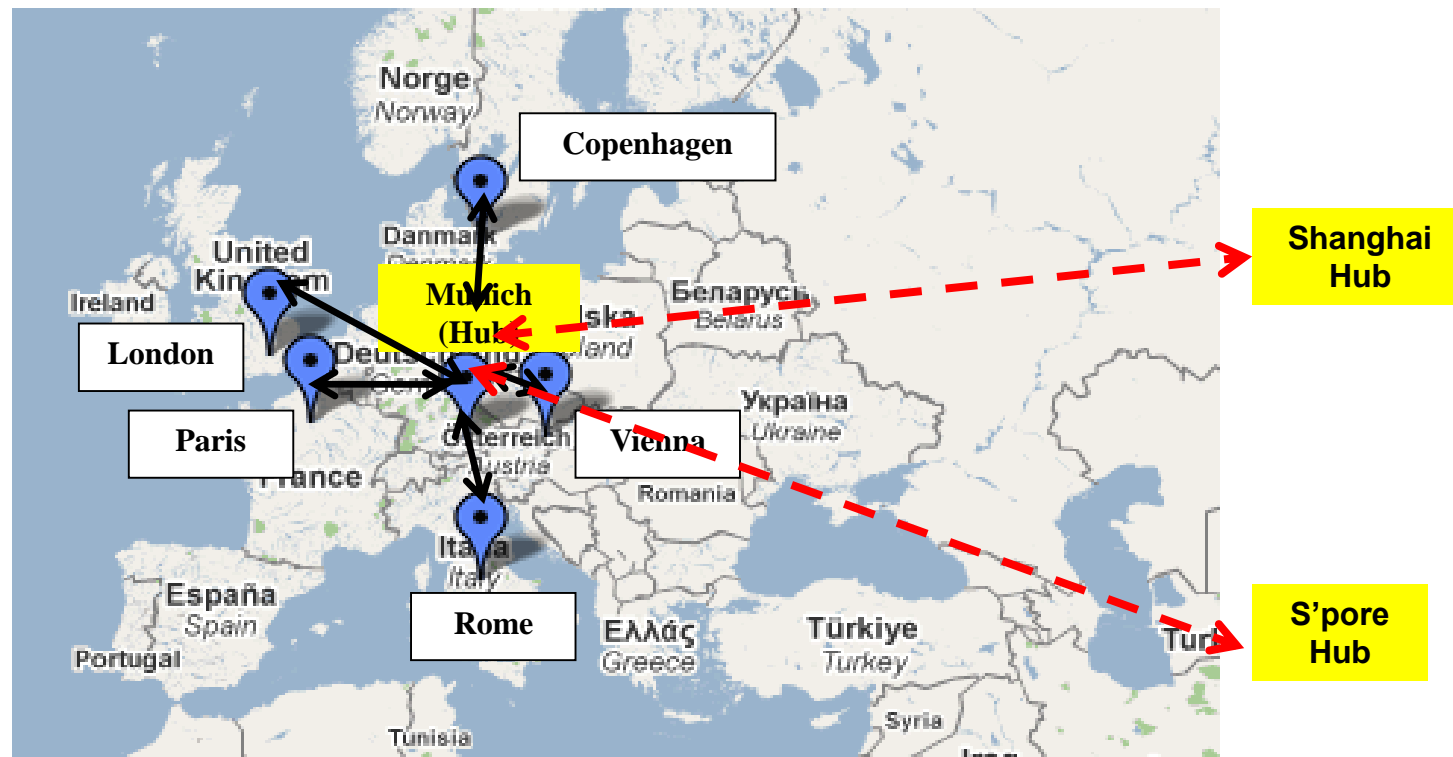


Europe (Hub in Munich)

Intra Hub



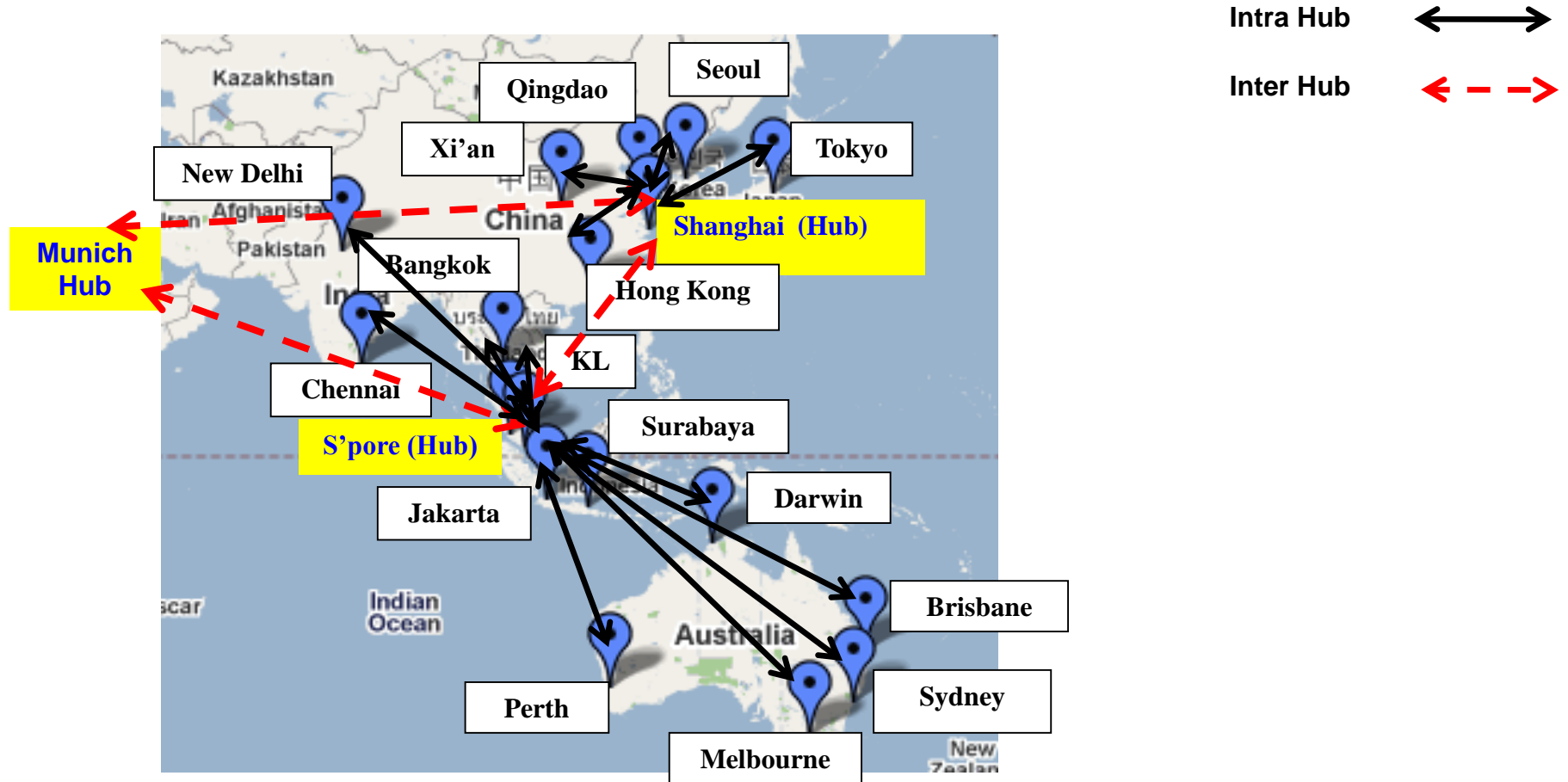
Inter Hub



Today's Problem (Task 1)



Asia Pacific (Hubs in Singapore & Shanghai)



Today's Problem (Task 2)



- It is important that John understands the concept of **Location Analysis**
 - Identify the type of industry that he is in, and the factors that he needs to consider
 - Understand the Global Location Factors that will affect his decision
 - Use a combination of methods in his analysis
 - Use **Center of Gravity (COG)** to roughly determine the location
 - Evaluate potential sites using methods such as **Load-Distance (LD)** and **Factor-Rating**

Location of Facility (COG)



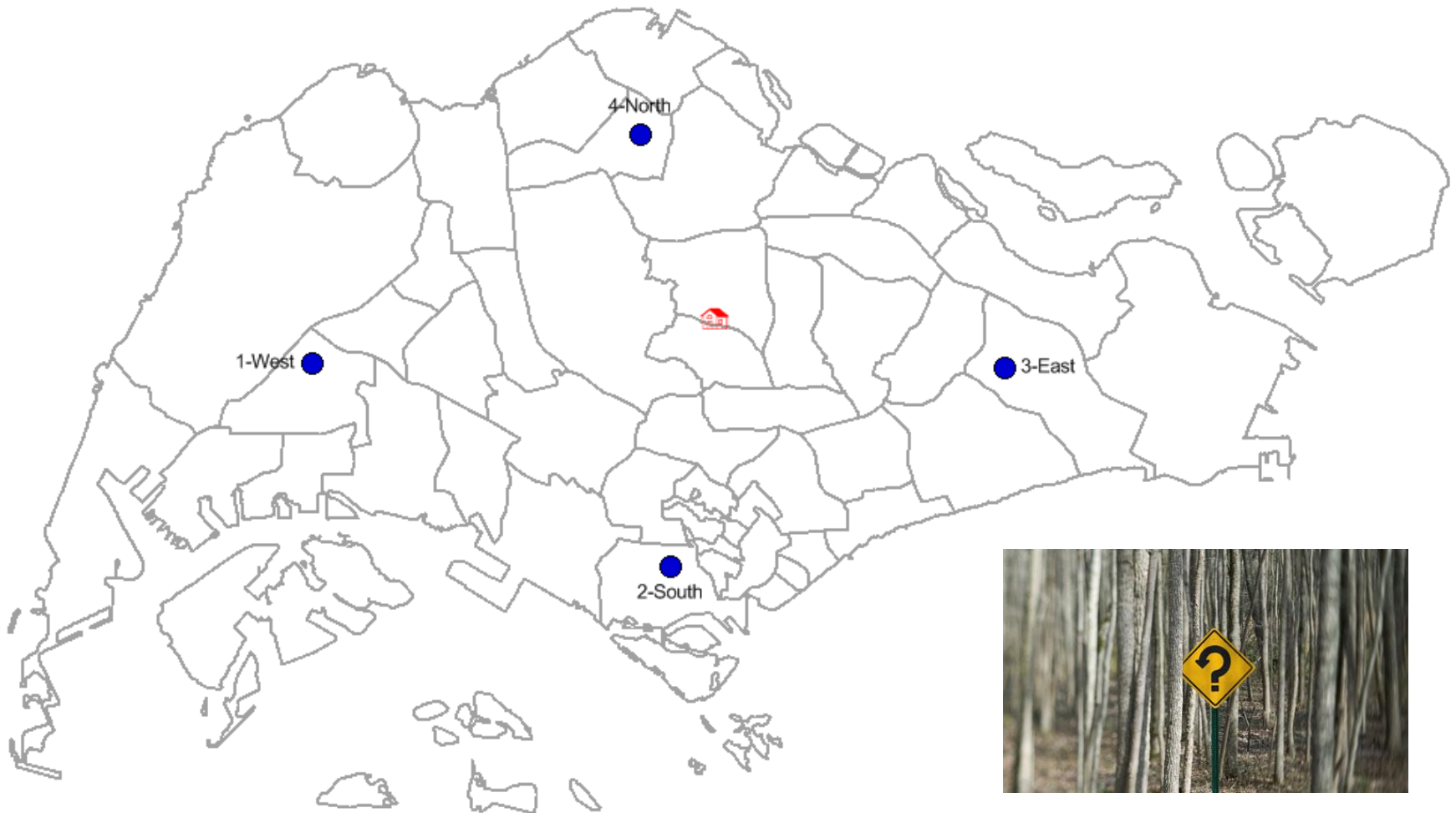
Suggested answer

Retailer	Longitude (x)	Latitude (y)	Weight (Daily replenishment in tons)	x * Weight	y * Weight
1 - West	13,866.10	37,079.70	5	69,330.50	185,398.50
2 - South	27,157.60	29,554.50	8	217,260.80	236,436.00
3 - East	39,585.70	36,947.20	12	475,028.40	443,366.40
4 - North	26,071.10	45,581.40	15	391,066.50	683,721.00
		Total	40	1,152,686.20	1,548,921.90
			Location Coordinates	28,817.16	38,723.05

Location of Facility (COG)



- DC is in the centre, which may be located among the forest, hence it is not a practical location.



Location of Site (L-D)



Potential Sites			
	A	B	C
X	19,688.82	34,009.72	33,602.99
Y	39,497.53	41,249.44	35,311.66

< Potential sites for DC

Retailers				
	1 - West	2 - South	3 - East	4 - North
X	13,866.10	27,157.60	39,585.70	26,071.10
Y	37,079.70	29,554.50	36,947.20	45,581.40
Weight	5	8	12	15

< Retailer locations

Note: It assumes a straight line distance between each DC and the supermarket

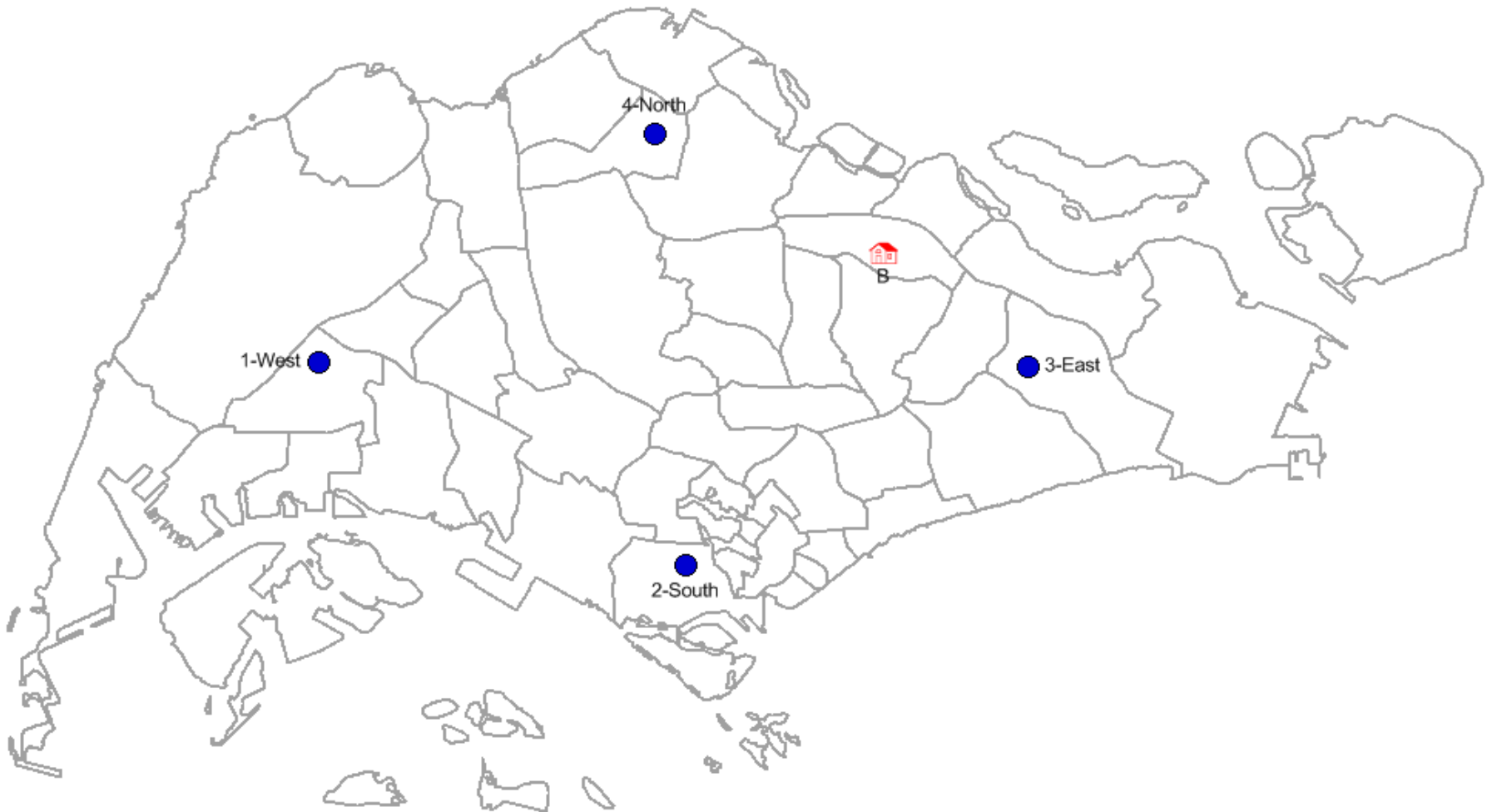
	A	B	C	Weight
1 - West	6304.757736	20570.66257	19815.9227	5
2 - South	12435.69541	13554.45204	8642.218669	8
3 - East	20059.66143	7042.785101	6202.242339	12
4 - North	8817.42435	9043.647768	12735.65572	15
Load Distance	503986.65	431457.07	433679.11	

- **Site B** has the lowest load-distance value, it can be assumed that this location would also minimize transportation costs.

Location of Site (L-D)



- **Site B** is chosen due to high weightage at East and North



Location Factor Rating



		Score (0 - 100)			Weighted Score		
Location Factor	Weight	A	B	C	A	B	C
Distribution accessibility	0.3	80	100	80	24	30	24
Land costs	0.4	90	80	84	36	24	33.6
Infrastructure	0.1	85	70	94	8.5	7	9.4
Construction costs	0.2	88	88	64	17.6	17.2	12.8
Total	1						
				Total	86.1	78.2	79.8



- **Site A** has the **highest factor rating (86.1)** compared to the other locations; however, this evaluation would have to be used with other information, particularly a cost analysis before making a decision

Learning Outcomes



- Describe terminal as a hub
 - Seaports
 - Airports
- Explain concept of Hub & Spoke
- Discuss International Aviation Control
 - Air Freedom Rights
- Explain the importance of facility location decisions
- Describe factors of affecting site selections
- Apply location analysis techniques

