

UNIT 7: DESIGNING THE SUPPLY CHAIN NETWORK

IT 229: IT Entrepreneurship and Supply Chain Management

Rjee Rakhal

Prepared by: Rjee Rakhal



Chapter Outline

- Role of distribution in supply chain
- Factors influencing distribution network design
- Design Option for a distribution Network
- E-business and the Distribution Network.
- Role of network design in supply chain.
- Factors influencing Network Design
- Decisions Frame work for Network design Decision



Role of distribution in supply chain

Meaning

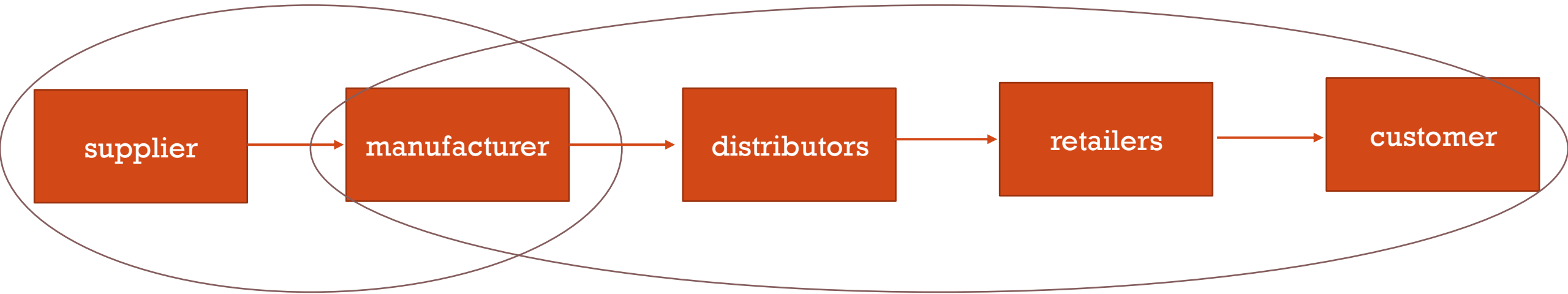


What is distribution?

- Distribution means to spread the product throughout the marketplace such that a large number of people can buy it.
- The movement of goods and services from the source through a distribution channel, right up to the final customer, consumer, or user, and the movement of payment in the opposite direction, right up to the original producer or supplier.
- Take place between different stages



Distribution



Raw materials
and components

Finished goods



Distribution involves doing the following things:

- A good transport system
- A good tracking system
- A good packaging
- Placement
- Taking back the goods



The Role of Distribution in the Supply Chain

- 1. It affects cost**
- 2. It affects customer experience**
- 3. It derives profitability**
- 4. Low Cost vs High Responsiveness**

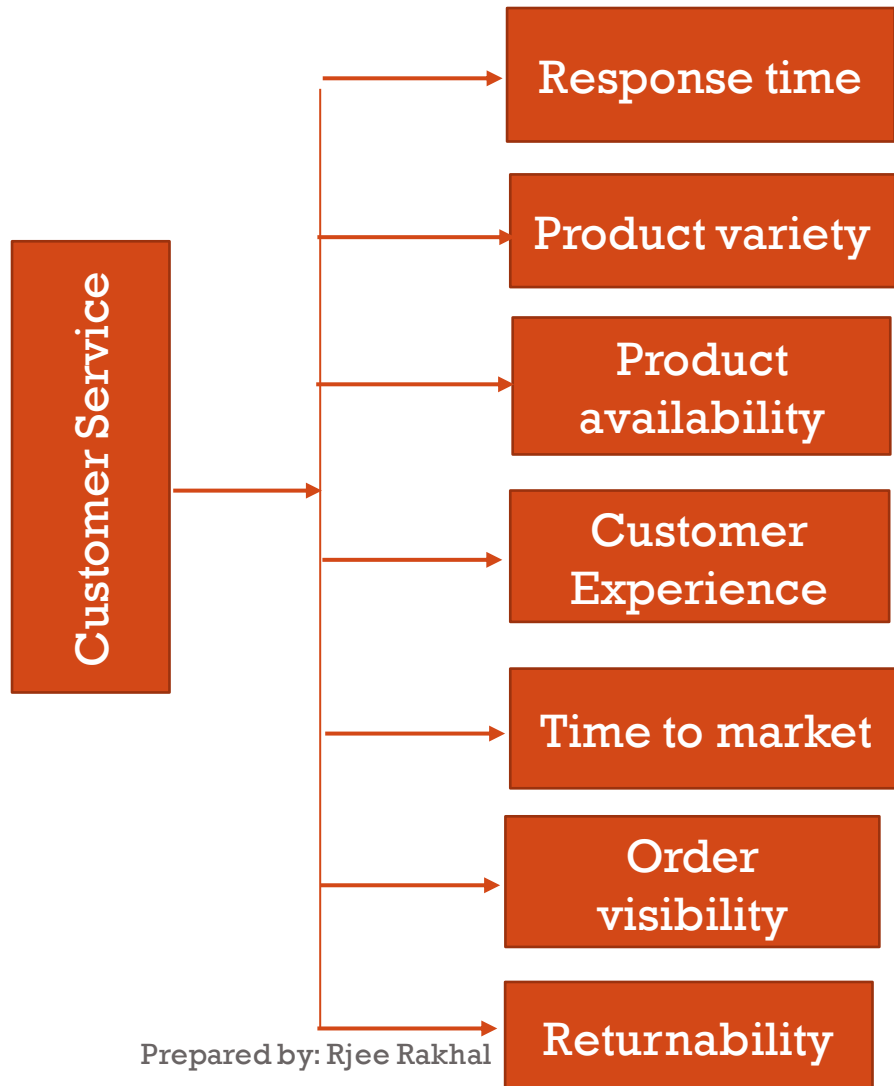


Factors Influencing Distribution Network Design

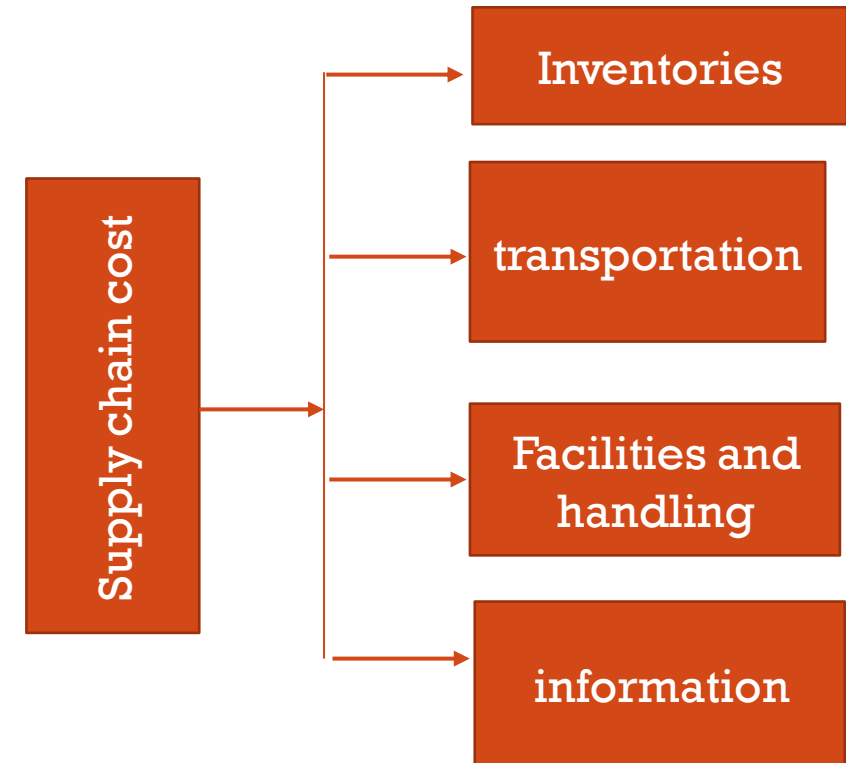
- Distribution network performance evaluated along two dimensions at the highest level:
 - Customer needs that are met
 - Cost of meeting customer needs
- The customers needs that are met influence the company's revenues, which along with cost decide the profitability of the delivery network.
- Distribution network design options must therefore be compared according to
 - their impact on customer service
 - the cost to provide this level of service



Distribution network design factors



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Factors Influencing Distribution Network Design

- Elements of customer service influenced by network structure:
 - **Response time** : Amount of time it takes for a customer to receive an order.
 - **Product variety**: Number of different products/configurations that are offered by the distribution network
 - **Product availability**: Probability of having a product in stock when a customer order arrives.
 - **Customer experience**: includes the ease with which customers can place and receive orders as well as the extent to which this experience is customized
 - **Order visibility**: Ability of customers to track their orders from placement to delivery
 - **Returnability**: Ease with which a customer can return unsatisfactory merchandise and the ability of the network to handle such returns



- **Firms that target customers who can tolerate a long response time require only a few locations that may be far from the customer. These companies can focus on increasing the capacity of each location. In contrast, firms that target customers who value short response times need to locate facilities close to them. These firms must have many facilities, each with a low capacity. Thus, a decrease in the response time customers desire increases the number of facilities required in the network.**

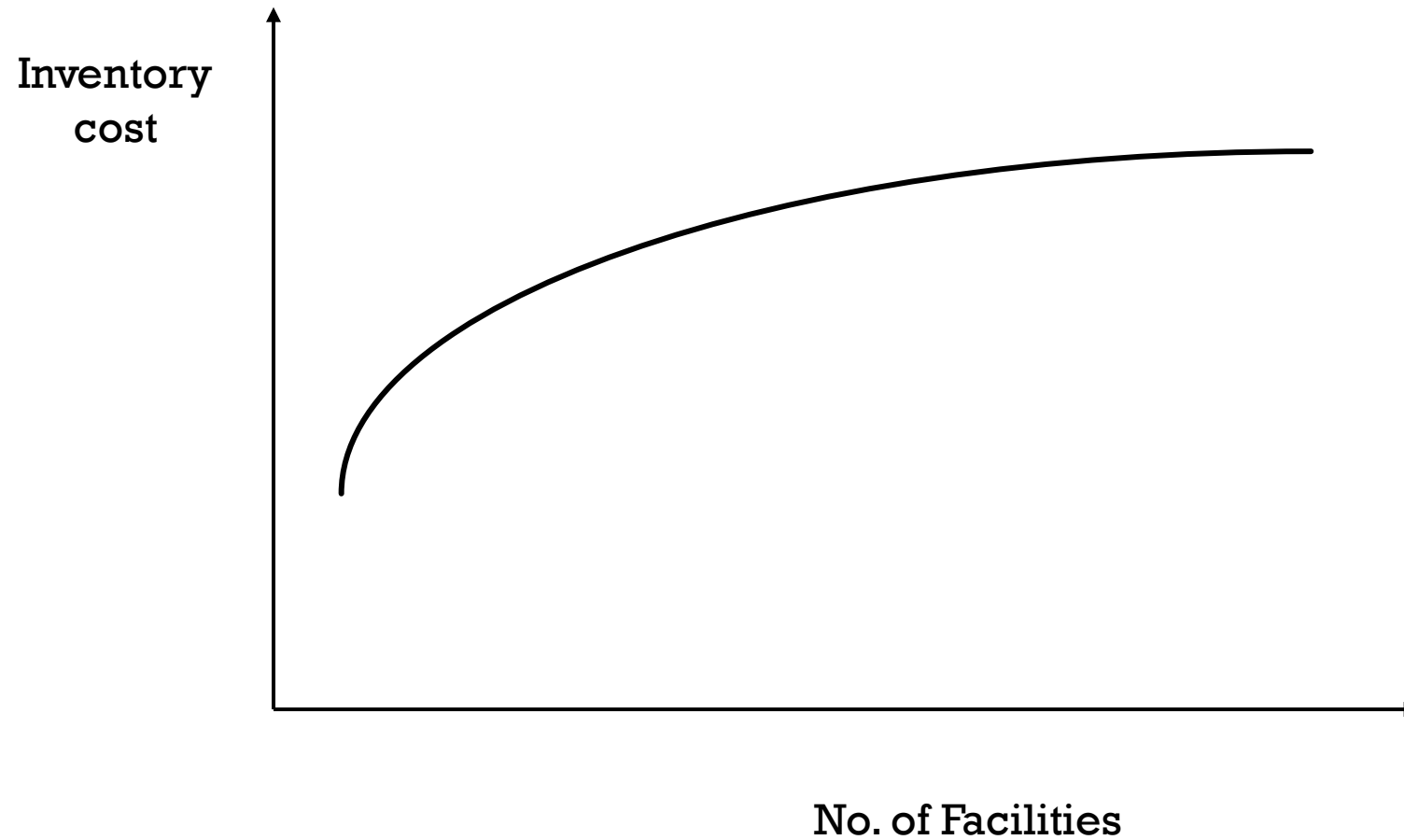


Supply Chain Costs Affected by Network Structure

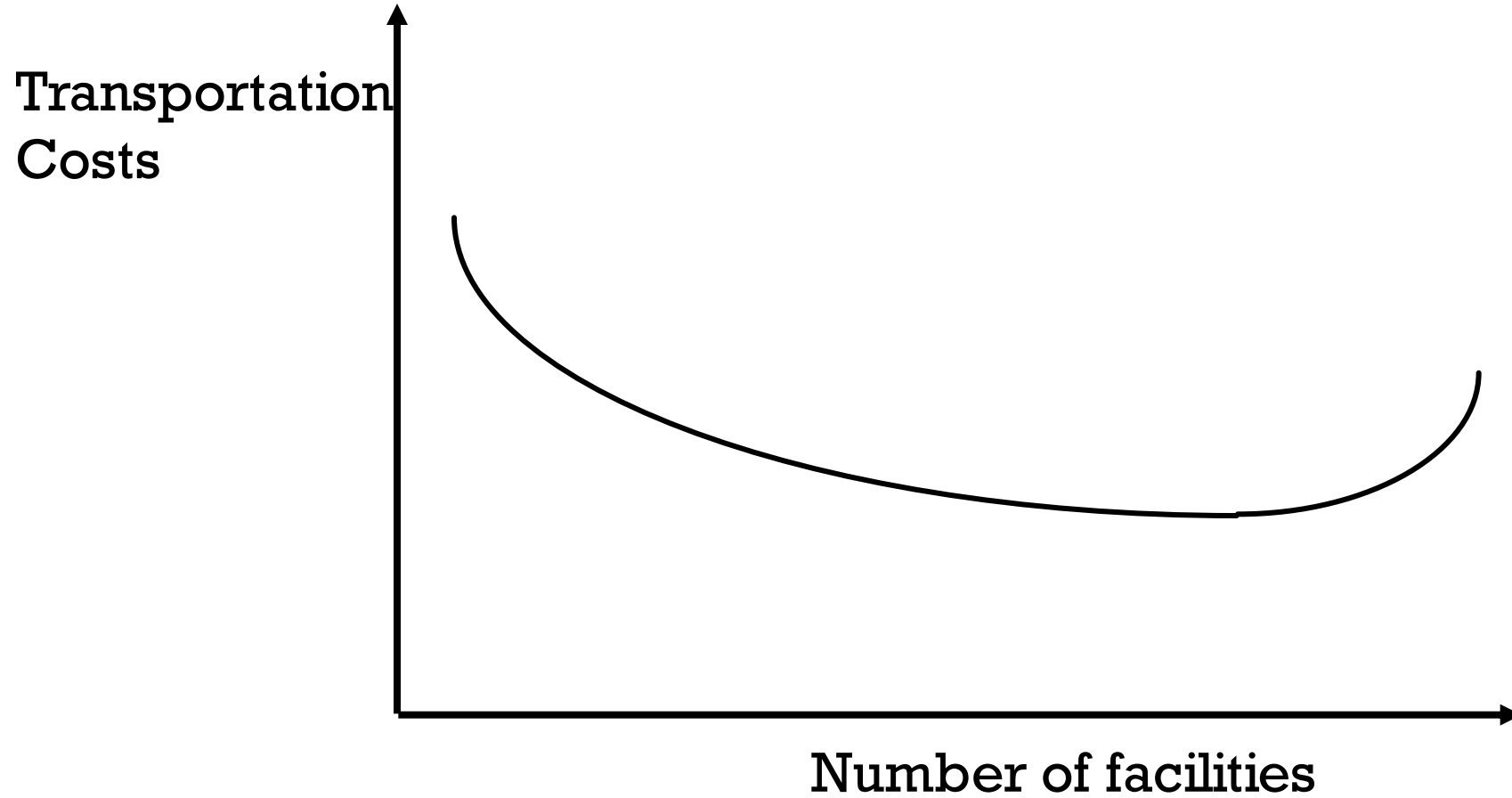
- Changing the distribution network design affects the following supply chain costs
 - **Inventories**
 - **Transportation**
 - **Facilities and handling**
 - **Information**
- A decrease in the response time customers desire increases the number of facilities required in the network.
- As the number of facilities in a supply chain increases, the inventory and resulting inventory costs also increase.



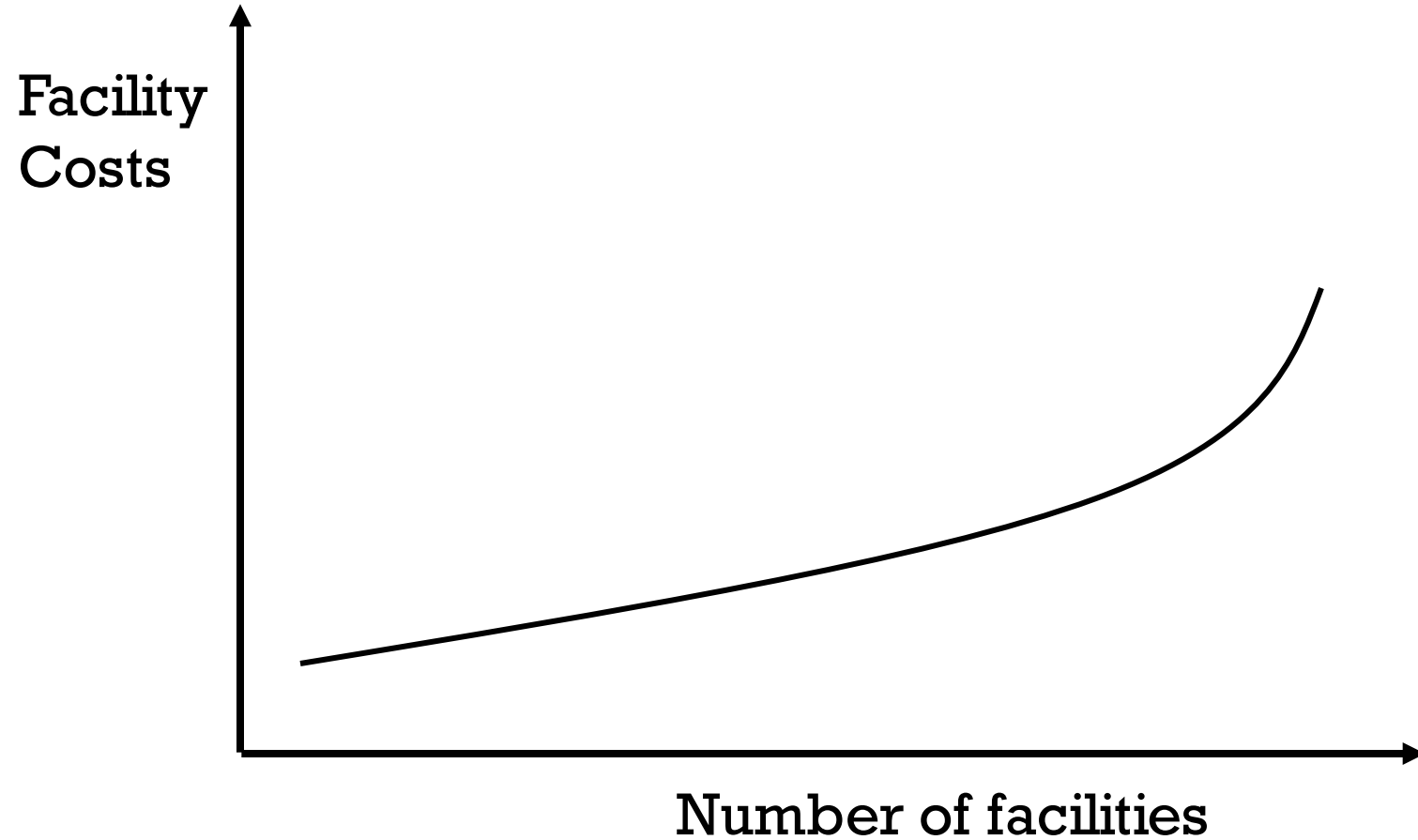
Inventory Costs and Number of Facilities



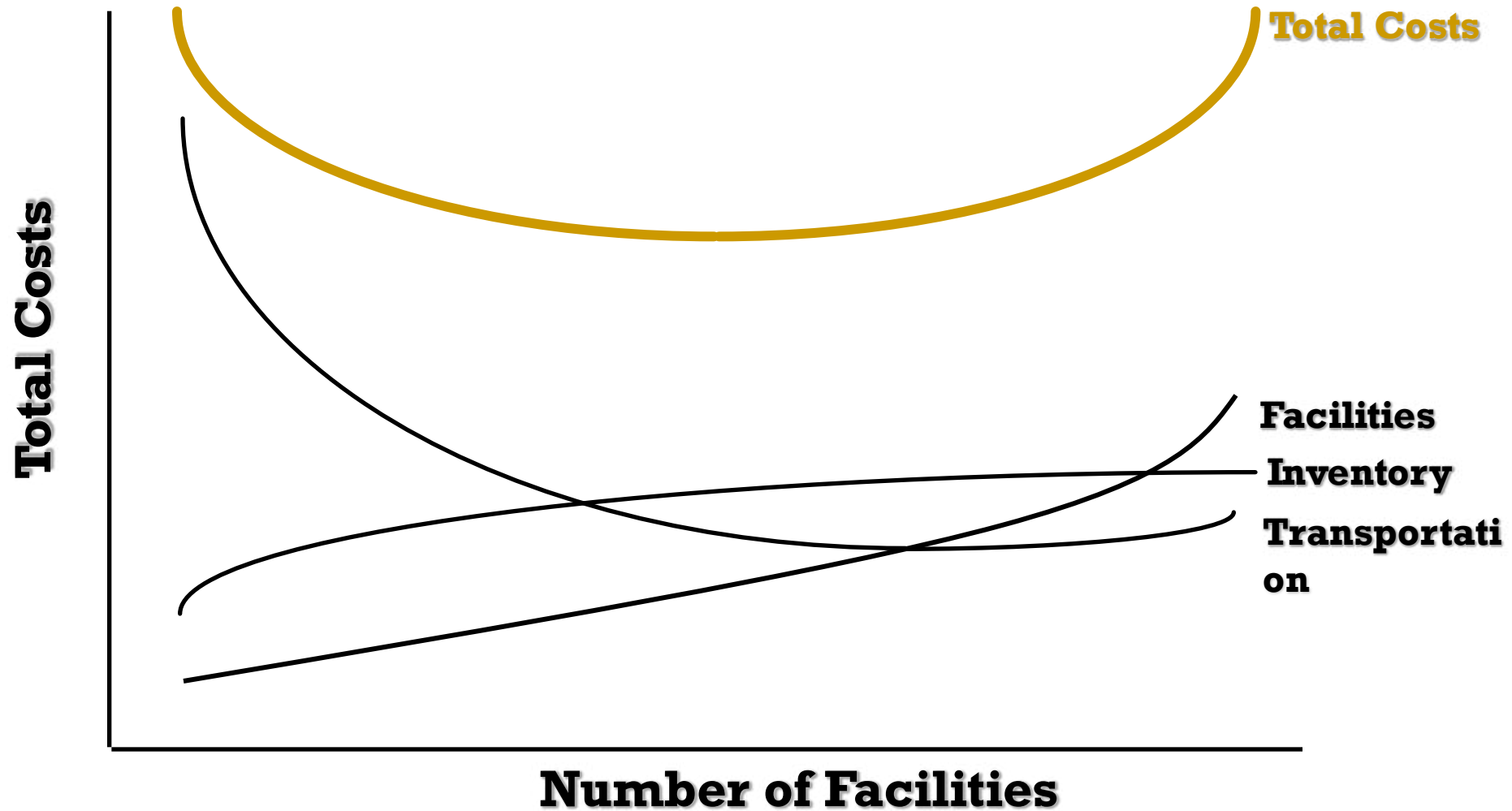
Transportation Costs and Number of Facilities



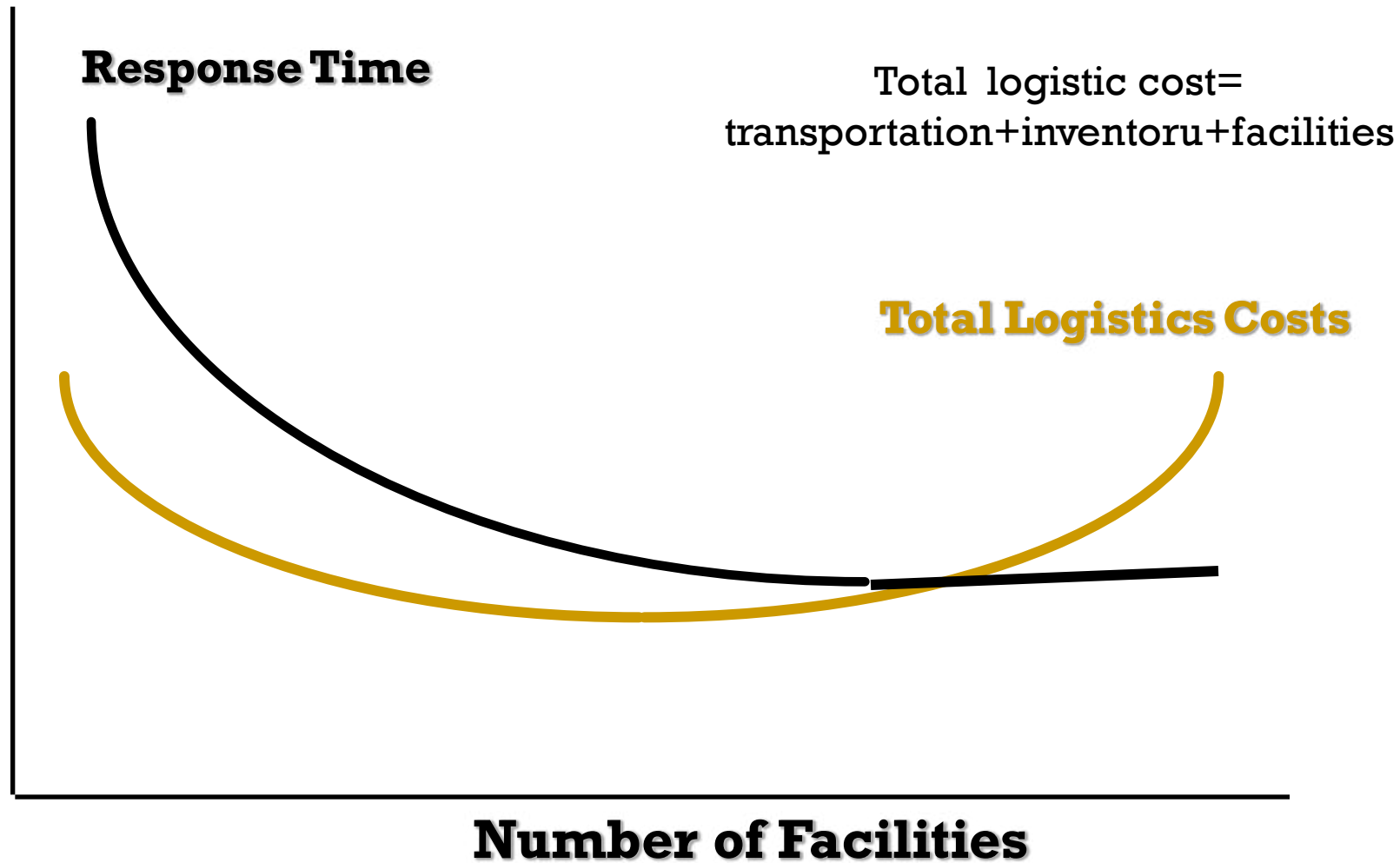
Facility Costs and Number of Facilities



Total Costs Related to Number of Facilities



Variation in Logistics Costs and Response Time with Number of Facilities



- If the number of facilities is increased to a point where inbound lot sizes are also very small and result in a significant loss of economies of scale in inbound transportation, increasing the number of facilities increases total transportation cost.
- Facility costs decrease as the number of facilities is reduced.
- Total logistics costs are the sum of inventory, transportation and facility costs for a supply chain network.
- As the number of facilities increases, total logistics costs first decrease and then increase. Each firm should have at least the number of facilities that minimize total logistics costs.
- As a firm wants to reduce the response time to its customers further, it may have to increase the number of facilities beyond the point that minimizes logistics costs.
- A firm should add facilities beyond the cost-minimizing point only if managers are confident that the increase in revenues because of better responsiveness is greater than the increase in costs because of the additional facilities



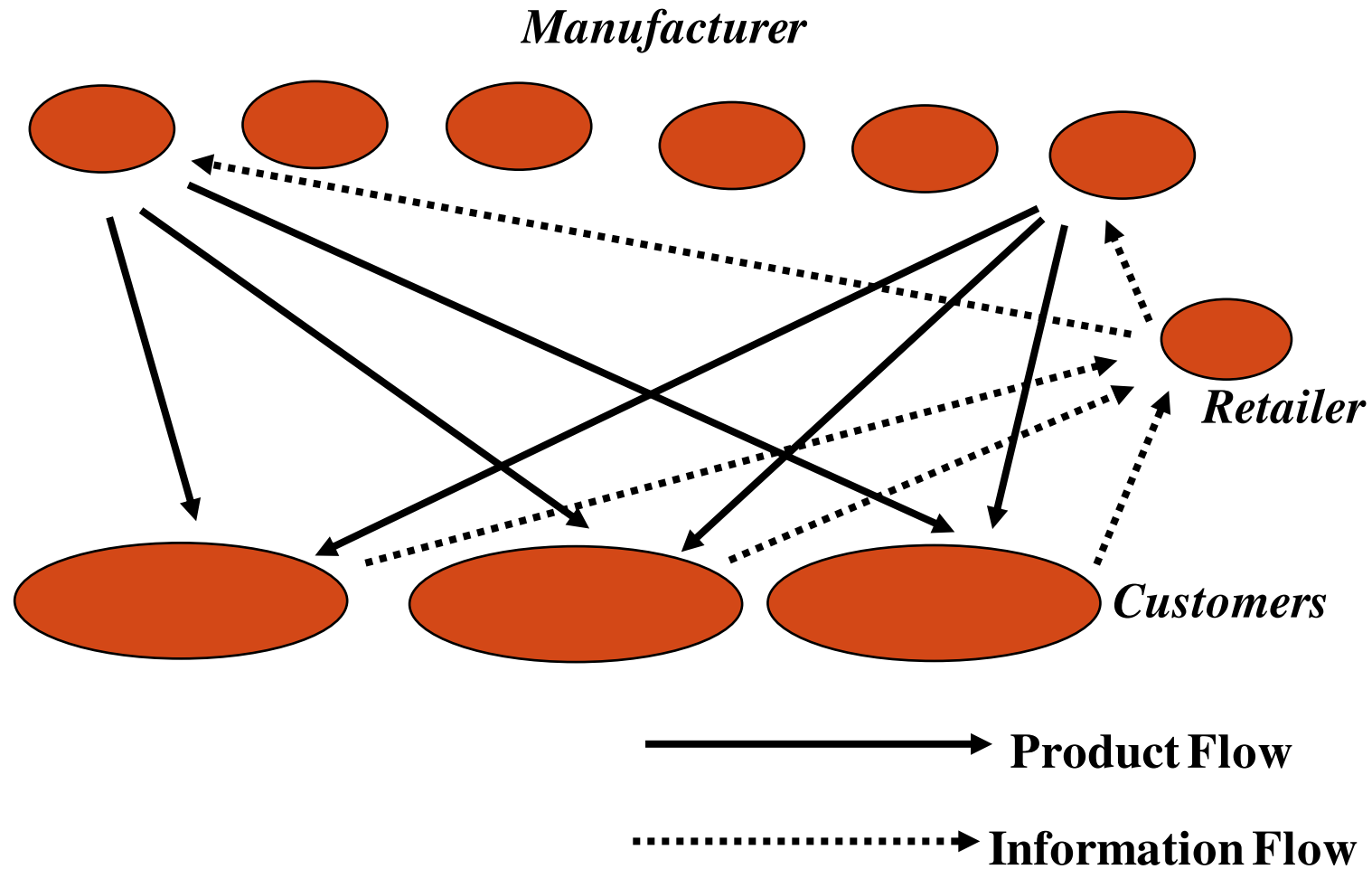
Design Options for a Distribution Network

2 Key decisions; that need to be made

- i. Will product be Delivered to the customer location/ picked up by customers*
- ii. Will product through Intermediary? Or intermediate location*

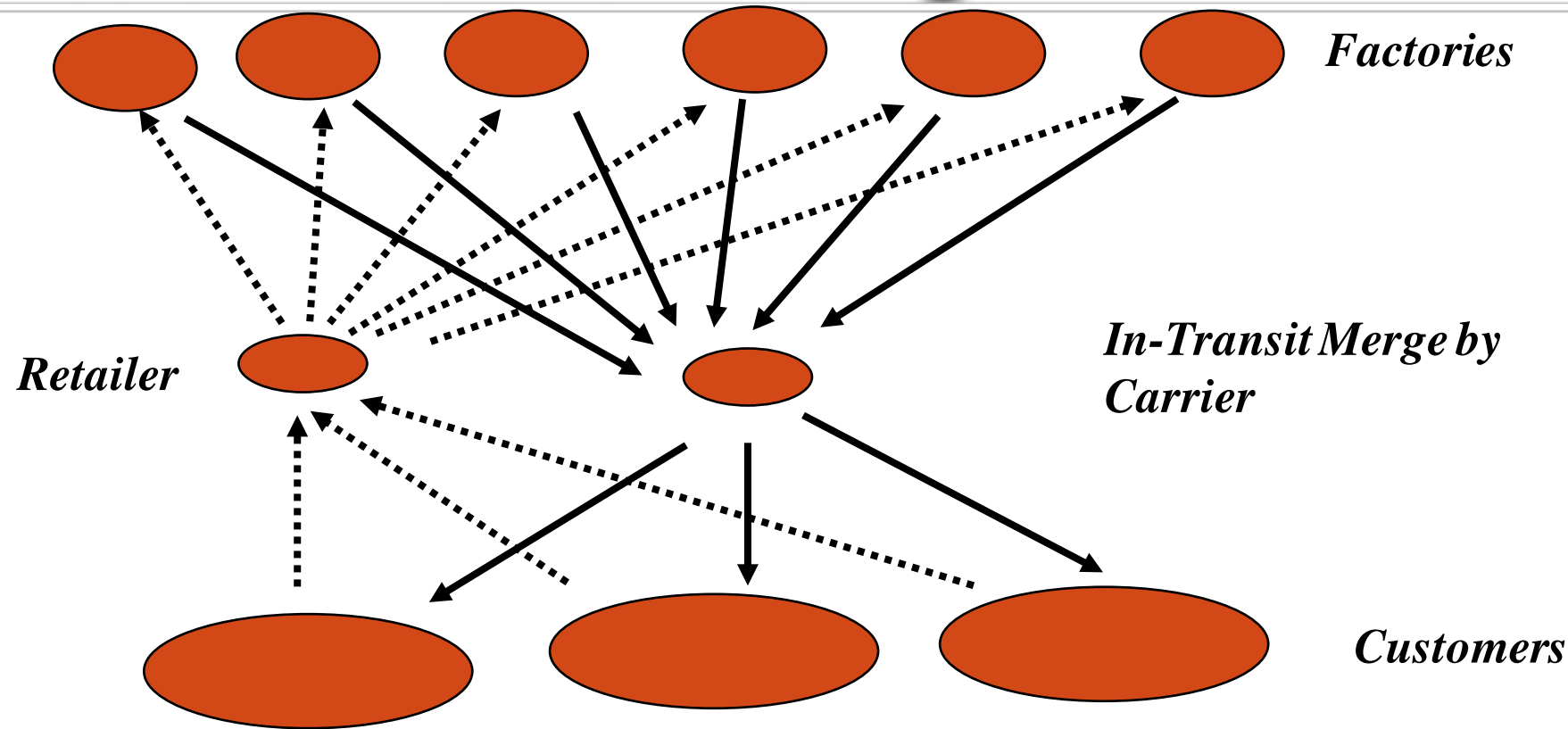
- 1. Manufacturer Storage with Direct Shipping**
- 2. Manufacturer Storage with Direct Shipping and In-Transit Merge**
- 3. Distributor Storage with Carrier Delivery**
- 4. Distributor Storage with Last Mile Delivery**
- 5. Manufacturer or Distributor Storage with Consumer Pickup**
- 6. Retail Storage with Consumer Pickup**

1. Manufacturer Storage with Direct Shipping



Drop-shipping

2. Manufacturer storage with direct shipping and in-transit merge



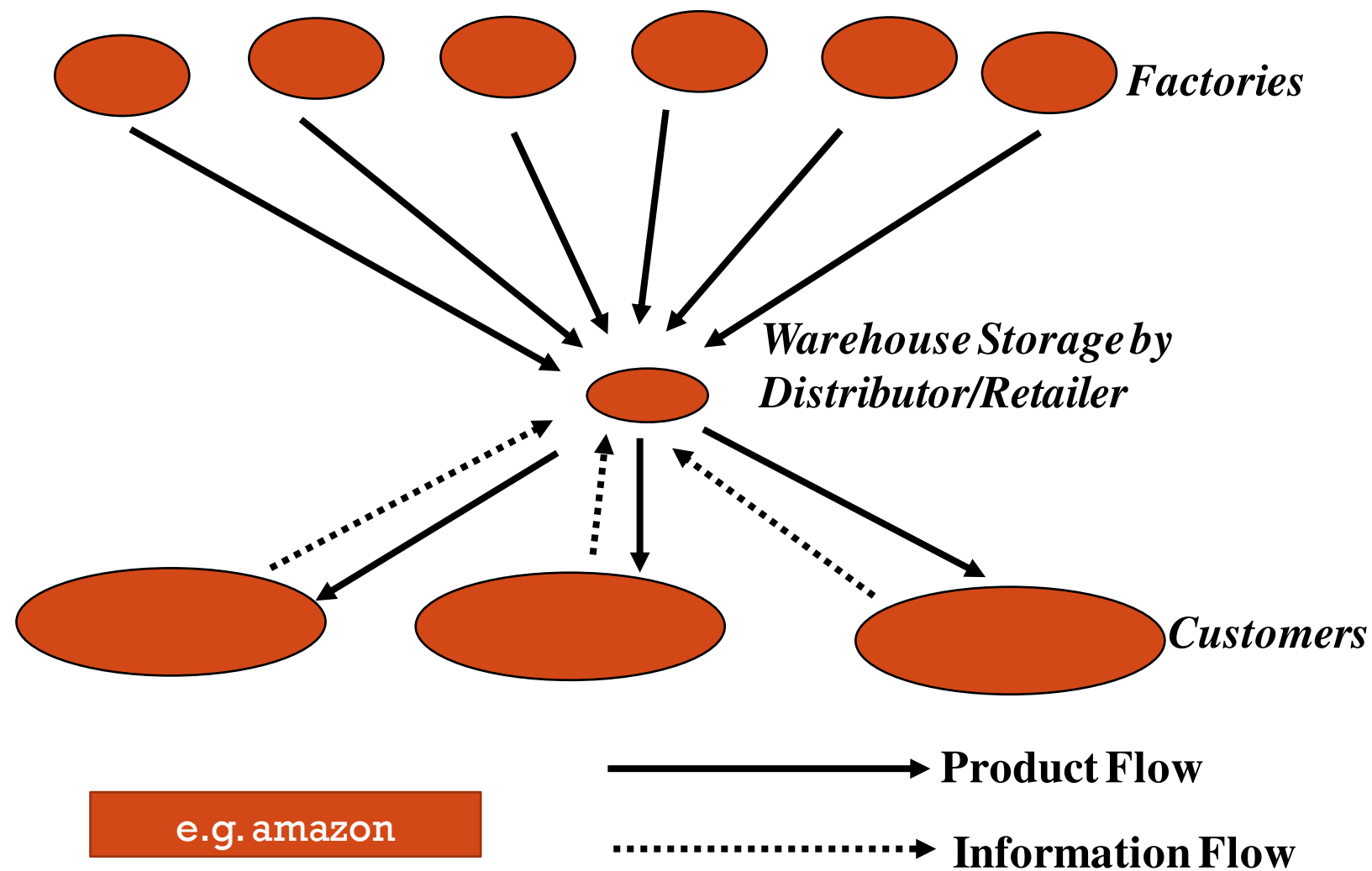
in-transit merge combines pieces of the order coming from different locations so that the customer gets a single delivery.

e.g.
Dell= pc
Sony= monitor
LG-= tv

—————→ **Product Flow**
.....→ **Information Flow**

Customer experience
= better, will not receive partial shipments

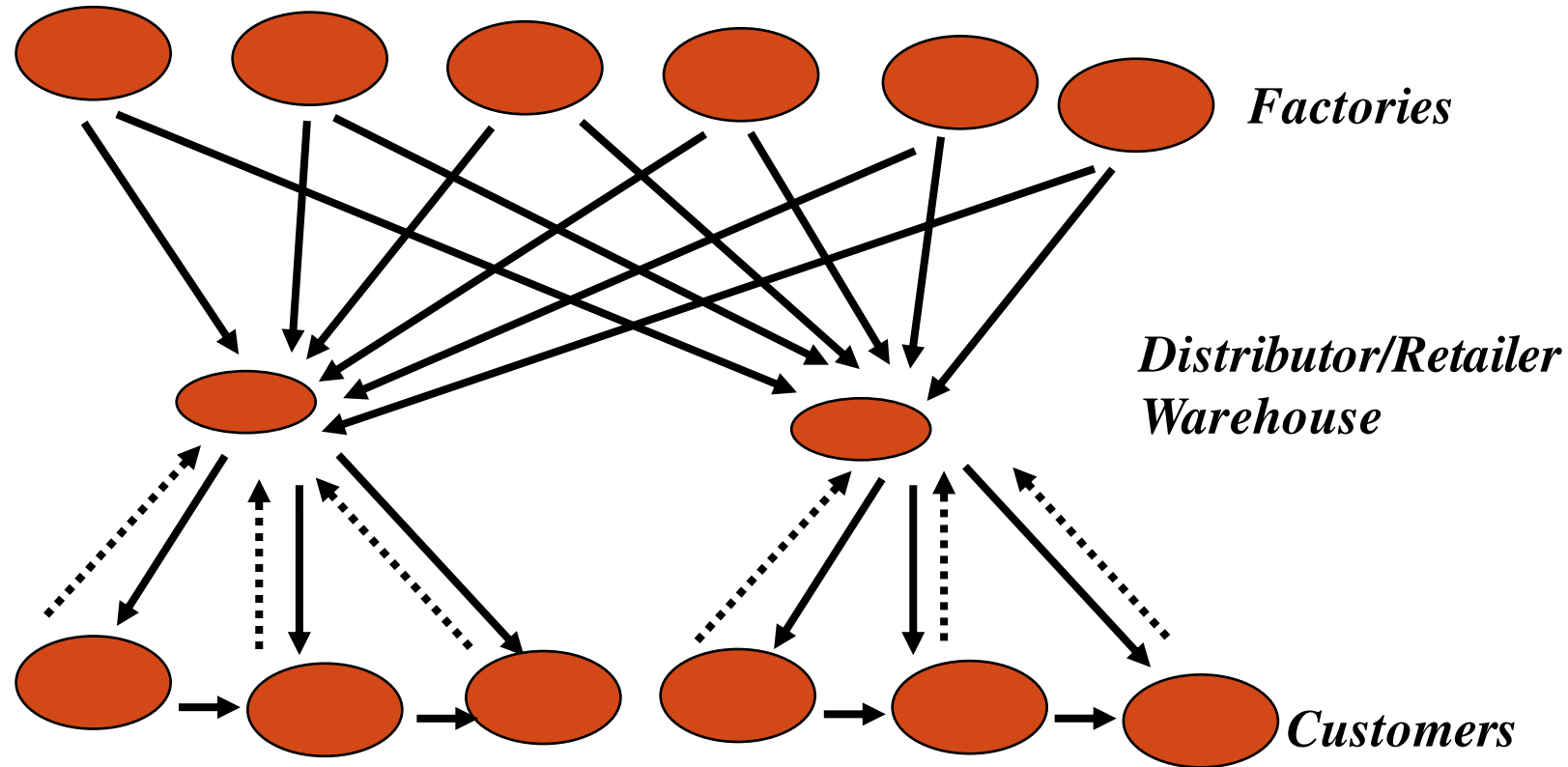
3. Distributor Storage with Carrier Delivery



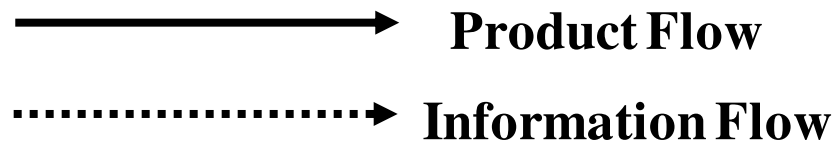
package carriers are used to transport products from the intermediate location to the final customer



4. Distributor Storage with Last Mile Delivery

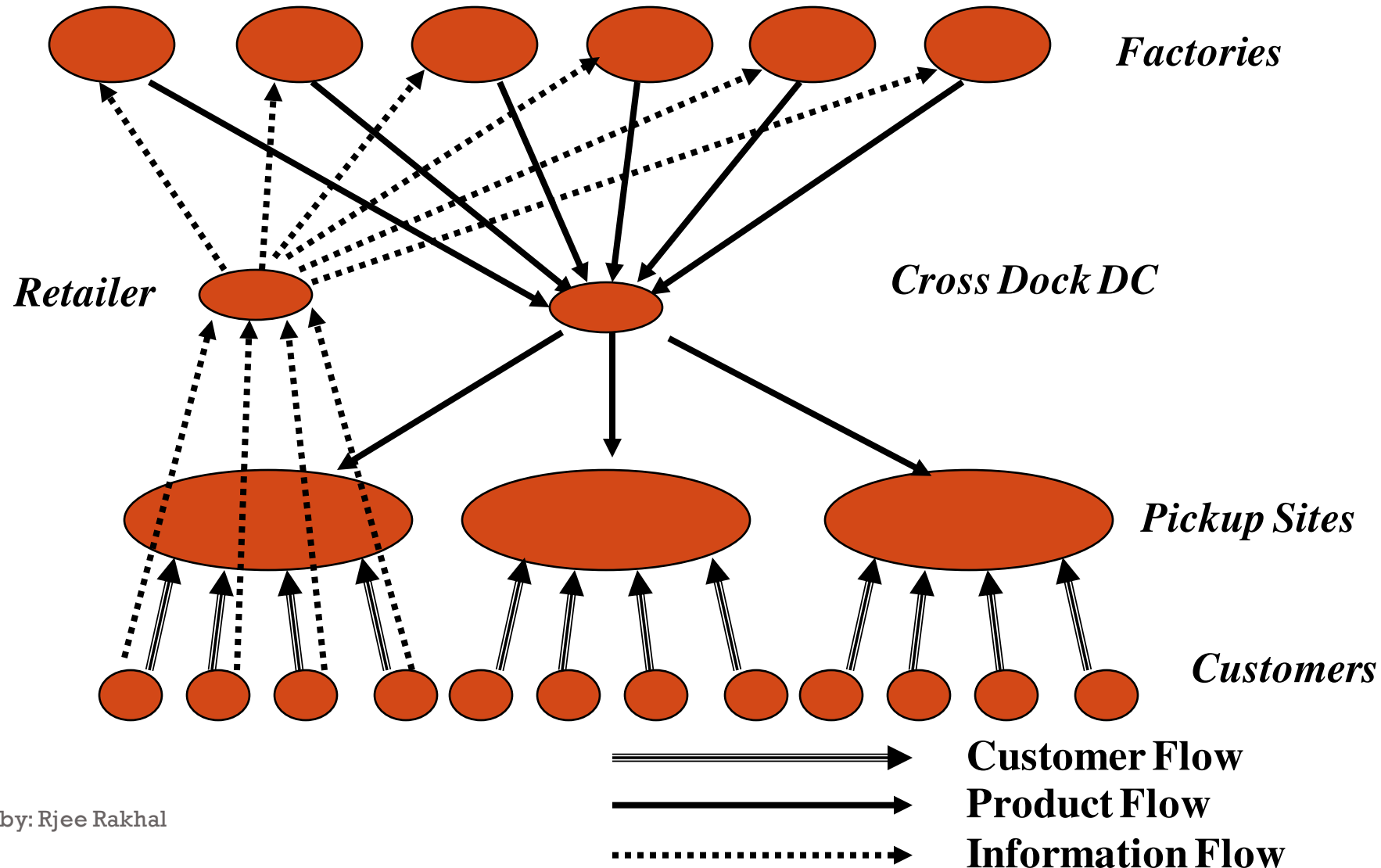


distributor/retailer delivering the product to the customer's home instead of using a package carrier.

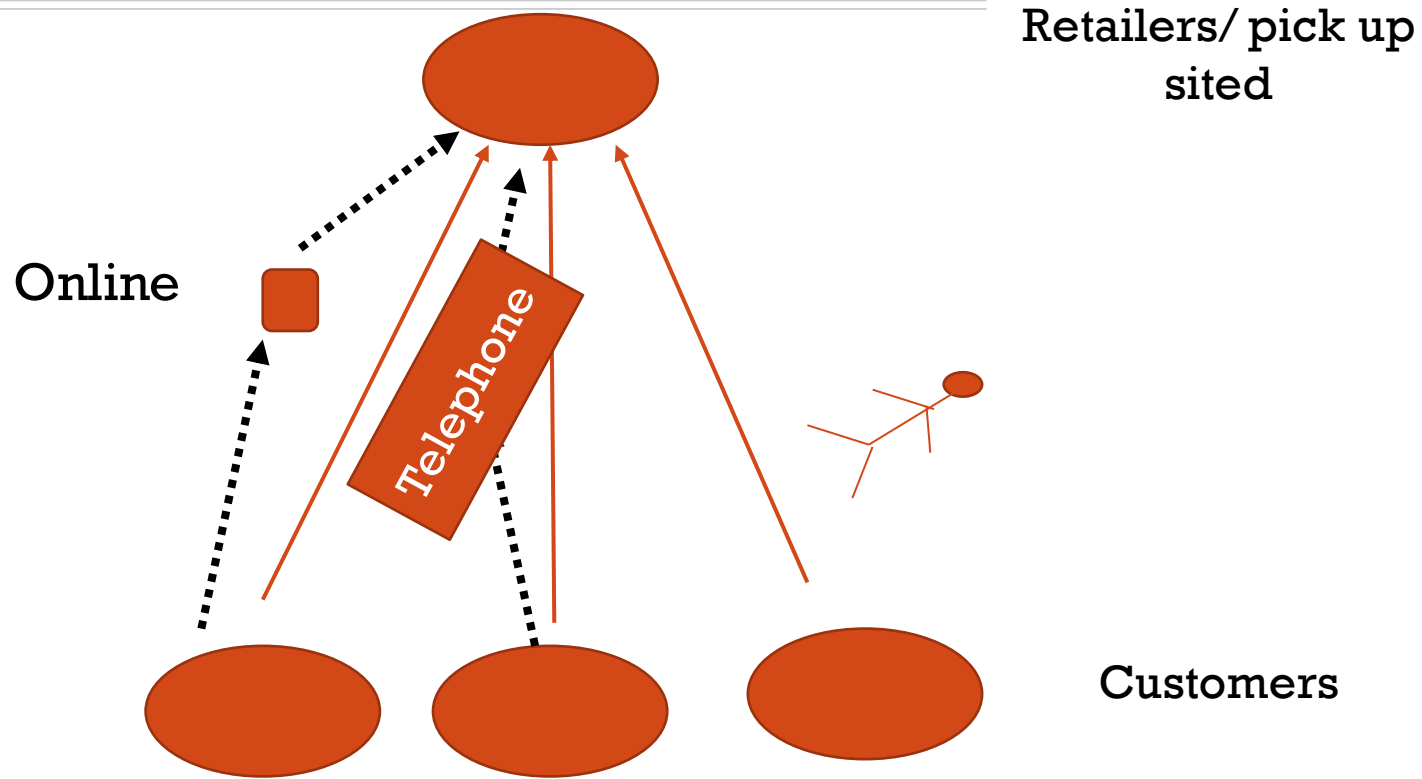


5. Manufacturer or Distributor Storage with Customer Pickup

Orders are shipped from the storage site to the pickup points as needed.



6. Retailer storage with Customer Pickup



Performance Characteristics of Manufacturer Storage with Direct Shipping Network

Cost Factor	Performance
Inventory	Lower costs because of aggregation.
Transportation	Higher transportation costs because of increased distance and disaggregate shipping.
Facilities and handling	Lower facility costs because of aggregation. Some saving on handling costs if manufacturer can manage small shipments or ship from production line
Information	Significant investment in information infrastructure to integrate manufacturer and retailer
Service Factor	Performance
Response Time	Long, because of increased distance and two stages for order processing.
Product Variety	High, retailers are in touch with so many manufacturers, customer can order in websites
Product Availability	High, because of aggregation of inventory at manufacturer
Customer Experience	Good in terms of home delivery but can suffer if order from several manufacturers is sent as partial shipments.
Time to market	Fast, with the product available as soon as the first unit is produced by manufacturer
Order visibility	difficult, so many manufacturers
Returnability	Expensive and difficult to implement



1. Manufacturer Storage with Direct Shipping

- Product is shipped directly from the manufacturer to the end customer, bypassing the retailer (who takes the order and initiates the delivery request).
- This option is also referred to as drop shipping, with product delivered directly from the manufacturer to the customer.
- It is best suited for a large variety of low-demand, high-value items for which customers are willing to wait for delivery and accept several partial shipments.



2. Manufacturer storage with direct shipping and in-transit merge

- Unlike pure dropshipping, under which each product in the order is sent directly from its manufacturer to the end customer, in-transit merge combines pieces of the order coming from different locations so that the customer gets a single delivery.
- For eg, when a customer orders a PC from Dell along with a Sony monitor, the package carrier picks up the PC from the Dell factory and the monitor from the Sony factory; it then merges the two together at a hub before making a single delivery to the customer.
- It is best suited for low-to medium demand, high value items the retailer is sourcing from a limited number of manufacturers.



Performance Characteristics of In-Transit Merge

Cost Factor	Performance
Inventory	Similar to drop shipping.
Transportation	Somewhat lower transportation costs than drop shipping.
Facilities and handling	Handling costs higher than drop shipping at carrier; receiving costs lower at customer.
Information	Investment is somewhat higher than for drop shipping. extra information need to b shared at in-transit merge

Service Factor	Performance
Response Time	Similar to drop-shipping; may be marginally higher.
Product variety	Similar to drop shipping.
Product Availability	Similar to drop-shipping.
Customer experience	Better than drop-shipping because single order has to be received.
Time to market	Similar to drop-shipping.
Order visibility	Similar to drop-shipping.
Return ability	Similar to drop-shipping.

3. Distributor Storage with Carrier Delivery

- Under this option, inventory is not held by manufacturers at the factories but is held by distributors/ retailers in intermediate warehouses, and package carriers are used to transport products from the intermediate location to the final customer.
- It is well suited for medium-to-fast moving items. It also makes sense when customers want delivery faster than is offered by manufacturer storage but do not need it immediately.



Performance Characteristics of Distributor Storage with Carrier Delivery

Cost Factor	Performance
Inventory	Higher than manufacturer storage. Difference is not large for faster-moving items.
Transportation	Lower than manufacturer storage. Reduction is highest for faster-moving items.
Facilities and handling	Somewhat higher than manufacturer storage. The difference can be large for very slow-moving items.
Information	Simpler infrastructure compared to manufacturer storage.

Service Factor	Performance
Response Time	Faster than manufacturer storage.
Product variety	Lower than manufacturer storage. More items cannot be storage at warehouse
Product availability	Higher cost to provide the same level of availability as manufacturer storage.
Customer experience	Better than manufacturer storage with drop-shipping.
Time to market	Higher than manufacturer storage.
Order visibility	Easier than manufacturer storage.
Return ability	Easier than manufacturer storage

4. Distributor Storage with Last Mile Delivery

- Last-mile delivery refers to the distributor/retailer delivering the product to the customer's home instead of using a package carrier.
- In areas with high labor costs, it is very hard to justify distributor storage with last mile delivery on the basis of efficiency or improved margin. It can only be justified if there is a large enough customer segment willing to pay for this convenience.
- An effort should be made to couple last mile delivery with an existing distribution network to exploit economies of scale and improve utilization.



Performance Characteristics of Distributor Storage with Last-Mile Delivery

Cost Factor	Performance
Inventory	Higher than distributor storage with package carrier delivery.
Transportation	Very high cost given minimal scale economies. Higher than any other distribution option.
Facilities and handling	Facility costs higher than manufacturer storage or distributor storage with package carrier delivery, but lower than a chain of retail stores.
Information	Similar to distributor storage with package carrier delivery.

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Service factor	Performance
Response time	Very quick. Same day to next-day delivery.
Product variety	Somewhat less than distributor storage with package carrier delivery but larger than retail stores.
Product availability	More expensive to provide availability than any other option except retail stores.
Customer experience	Very good, particularly for bulky items.
Time to market	Slightly higher than distributor storage with package carrier delivery.
Order traceability	Less of an issue and easier to implement than manufacturer storage or distributor storage with package carrier delivery.
Return ability	Easier to implement than other options. Harder and more expensive

5. Manufacturer or Distributor Storage with Customer Pickup

- Inventory is stored at the manufacturer or distributor warehouse but customers place their orders online or on the phone and then travel to designated pickup points to collect their merchandise.
- Orders are shipped from the storage site to the pickup points as needed.
- Such a network is likely to be most effective if existing locations such as coffee shops, convenience stores, or grocery stores are used as pickup sites, because this type of network improves the economies from existing infrastructure.



Performance Characteristics of Network with Consumer Pickup sites

Cost Factor	Performance
Inventory	Can match any other option, depending on the location of inventory.
Transportation	Lower than the use of package carriers, especially if using an existing delivery network.
Facilities and handling	Facility costs can be very high if new facilities have to be built. Costs are lower if existing facilities are used. The increase in handling cost at the pickup site can be significant.
Information	Significant investment in infrastructure required.

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Service Factor	Performance
Response time	Similar to package carrier delivery with manufacturer or distributor storage. Same day delivery possible for items stored locally at pick-up sites.
Product variety	Similar to other manufacturer or distributor storage options.
Product availability	Similar to other manufacturer or distributor storage options.
Customer experience	Lower than other options because of the lack of home delivery. In areas with high density of population, loss of convenience may be small.
Time to market	Similar to manufacturer storage options.
Order visibility	Difficult but essential.
Return ability	Somewhat easier given that pickup location can handle returns.

6. Retailer storage with Customer Pickup

- Inventory is stored locally at retail stores. Customers walk into the retail store or place an order online or by phone and pick it up at the retail store.
- It is best suited for fast-moving items or items for which customers value rapid response
- One of the most traditional type of supply chain



Performance Characteristics of Retail storage at Consumer Pickup sites

Cost Factor	Performance
Inventory	Higher than all other options.
Transportation	Lower than all other options.
Facilities and handling	Higher than other options. The increase in handling cost at pickup site can be significant for online and phone orders.
Information	Some investment in infrastructure required for online and phone orders.

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Service Factor	Performance
Response time	Same-day pickup possible for items stored locally at pickup site.
Product variety	Lower than all other options.
Product availability	More expensive to provide than all other options.
Customer experience	Related to whether shopping is viewed as a positive or negative experience by customer.
Time to market	Highest among distribution options.
Order visibility	Trivial for in-store orders. Difficult, but essential, for online & phone orders.
Return ability	Easier than other options given that pickup location can handle returns.

Crossdocking:

- product is not actually warehoused in the facility, instead the facility is used to house a process where trucks from suppliers arrive and unload large quantities of different products. These large lots are then broken down into smaller lots. Smaller lots of different products are recombined according to the needs of the day and quickly loaded onto outbound trucks that deliver the product to their final destination.



E-Business and the Distribution Network:

Impact of E-Business on Customer Service

■ **Response time to customers-**

- In selling physical products, an e-business without a physical retail outlet takes longer to fulfill a customer request than a retail store because of the shipping time involved.
- There is no such delay, for the products which can be downloaded such as ebooks, software, music, movie.

■ **Product Variety –**

- An e-business finds it easier to offer a large selection of products e.g amazon

■ **Product availability –**

- An e-business can greatly increase the speed with which information on customer demand is disseminated throughout the supply chain, giving rise to more accurate forecasts.
- These improved forecasts and the more accurate view of customer demand leads to a better match between supply and demand.



Impact of E-Business on Customer Service

■ **Customer Experience –**

- In terms of access, customization and convenience.
 - An e-business allows access to customers who may not be able to place orders during regular business hours.
 - An e-business allows a firm to access customers who are geographically distant.
 - Firms that focus on mass customization can use the Internet to help customers select a product that suits their needs.

■ **Time to market –**

- Can introduce new products much more quickly than through physical channels.

■ **Order Visibility –**

- The internet makes it possible to provide visibility of order status. Order info, company info, location info.



Impact of E-Business on Customer Service

■ **Returnability –**

- It is harder with online orders, which typically arrive from a centralized location.
- The proportion of returns is also likely to be much higher for online orders because the customers are unable to touch and feel the product before their purchase.

■ **Direct Sales to Customers –**

- An e-business allows manufacturers and other members of the supply chain that do not have direct contact with customers in traditional channels to enhance revenues by bypassing intermediaries and selling directly to customers, thereby collecting the intermediary's incremental revenue.
- E.g facebook, tweeter

■ **Flexible Pricing, Product Portfolio and Promotions –**

- An e-business can easily alter prices by changing one entry in the database linked to its website. This ability allows an e-business to maximize revenues by setting prices based on current inventories and demand. For eg, the airlines make last-minute, low cost fares available on the Web on routes with unsold seats. Can easily alter the product portfolio that it offers as well as the promotions it is running.

■ **Efficient Funds Transfer –**

- An e-business can enhance revenues by speeding up collection. E,g credit cards,



Impact of e-business on cost

■ **Inventory –**

- lower inventory levels and inventory cost by improving supply chain coordination and creating a better match between supply and demand. And inventory is aggregated at warehouse

■ **Facilities –**

- Two basic types of facilities costs must be included in the analysis: costs related to the number and location of facilities in a network, and costs associated with the operations that take place in these facilities.
- An e-business can reduce network facility costs by centralizing operations, thereby decreasing the number of facilities required. With regard to ongoing operating costs, customer participation in selection and order placement allows an e-business to lower its resource costs.

■ **Transportation –**

- If a firm can put its product in a form that can be downloaded, the internet will allow it to save on the cost and time for delivery.
- For non-digital products, aggregating inventories increases outbound transportation relative to inbound transportation.

■ **Information –**

- An e-business can share demand information throughout its supply chain **to improve visibility**. The internet may also be used to share planning and forecasting information within the supply chain, further improving **coordination**. This helps reduce overall supply chain costs and better match supply and demand



Network Design in Supply Chain



Outline

- Role of network design in supply chain
- Factors influencing Network Design Decisions
- Frame work for Network design Decision
- Network optimization Models
 - The capacitated plant location model
 - Gravity Location model



The Role of Network Design in the Supply Chain

- **Facility role –**
 - What role should each facility play? What processes are performed at each facility?
- **Facility location –**
 - Where should facilities be located?
- **Capacity allocation –**
 - How much capacity should be allocated to each facility? (affects prodn, inventory, & transp. Cost)
- **Market and supply allocation –**
 - What markets should each facility serve? Which supply sources should feed each facility?

Factors Influencing Network Design Decisions

1. Strategic

2. Technological e.g. computer chips; coca-cola

3. Macroeconomic

- *Tariffs & taxes incentives, exchange rate & demand risk, freight and fuel cost*

4. Political

5. Infrastructure

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6. Competitive

- *Positive externalities between firms*
- *Locating to split the market*

7. Customer response time and local presence

8. Logistics and facility costs



1. Strategic Factors

- Firms that focus on cost leadership tend to find the lowest cost location for their manufacturing facilities, even if that means locating very far from the markets they serve.
- Firms that focus on responsiveness tend to locate facilities closer to the market and may select a high-cost location if this choice allows the firm to react quickly to changing market needs.

2. Technological factors

- If production technology displays significant economies of scale, a few high-capacity locations are most effective.
- If facilities have lower fixed costs, many local facilities are preferred because this helps lower transportation costs.
- If the fixed cost of setting up facility is high, few facility location is a feasible option but if setting up fixed cost is low, more number of facilities should be established.

3. Macroeconomic Factors

■ Tariffs and Tax Incentives –

- Tariffs refer to any duties that must be paid when product and/or equipment are moved across international, state, or city boundaries.
- If a country has very high tariffs, companies either do not serve the local market or set up manufacturing plants within the country to save on duties.
- Tax incentives are a reduction in tariffs or taxes that countries, states and cities often provide to encourage firms to locate their facilities in specific areas. Trade Blocs like SAARC, BRIC, European Union are formed in order to promote trade amongst the member countries.
- Developing countries often create Special Economic Zones in which duties and tariffs are relaxed as long as production is used primarily for export.



cont...

■ **Exchange Rate and Demand Risk –**

- Fluctuations in exchange rates are common and have a significant impact on the profits of any supply chain serving global markets.
- A firm that sells its product in the United States with production in India is exposed to the risk of appreciation of the rupee.
- Companies must also take into account fluctuations in demand caused by changes in the economies of different countries.
- For eg. Firms with little production flexibility experienced unutilized capacity in Indian plants when Indian economies slowed down between 2008 and 2009.
- Firms with greater flexibility in their manufacturing facilities were able to use the extra capacity in their Indian plants to meet the needs of other countries where demand was high



4. Political factors —

- Companies prefer to locate facilities in politically stable countries where the rules of commerce and ownership are well defined.
- Countries with independent and clear legal systems allow firms to feel that they have recourse in the courts should they need it.



5. Infrastructure Factors –

- Key infrastructure elements to be considered during network design
 - availability of sites,
 - labor availability,
 - proximity to transportation terminals, rail service, proximity to airports and seaports, highway access, congestion and local utilities.

6. Competitive Factors –

- Companies must consider competitor's strategy, size and location when designing their supply chain networks.
- **Positive externalities** are instances where the collocation of multiple firms benefits all of them. It leads to competitors locating close to each other.
 - For eg, gas stations and retail stores tend to locate close to each other because doing so increases the overall demand, thus benefiting all parties.
- In malls, retailers are located close to each other, thus providing convenience to the customers and benefitted themselves by increase in sales.
- Locating to split the market share: when there is no positive externalities, firm locate to capture largest possible market share

7. Customer response time and local presence

- If firm's Target customer prefer quick response time, must locate close to them
- Local presence: coffee shop (customers will not like to travel to have coffee)

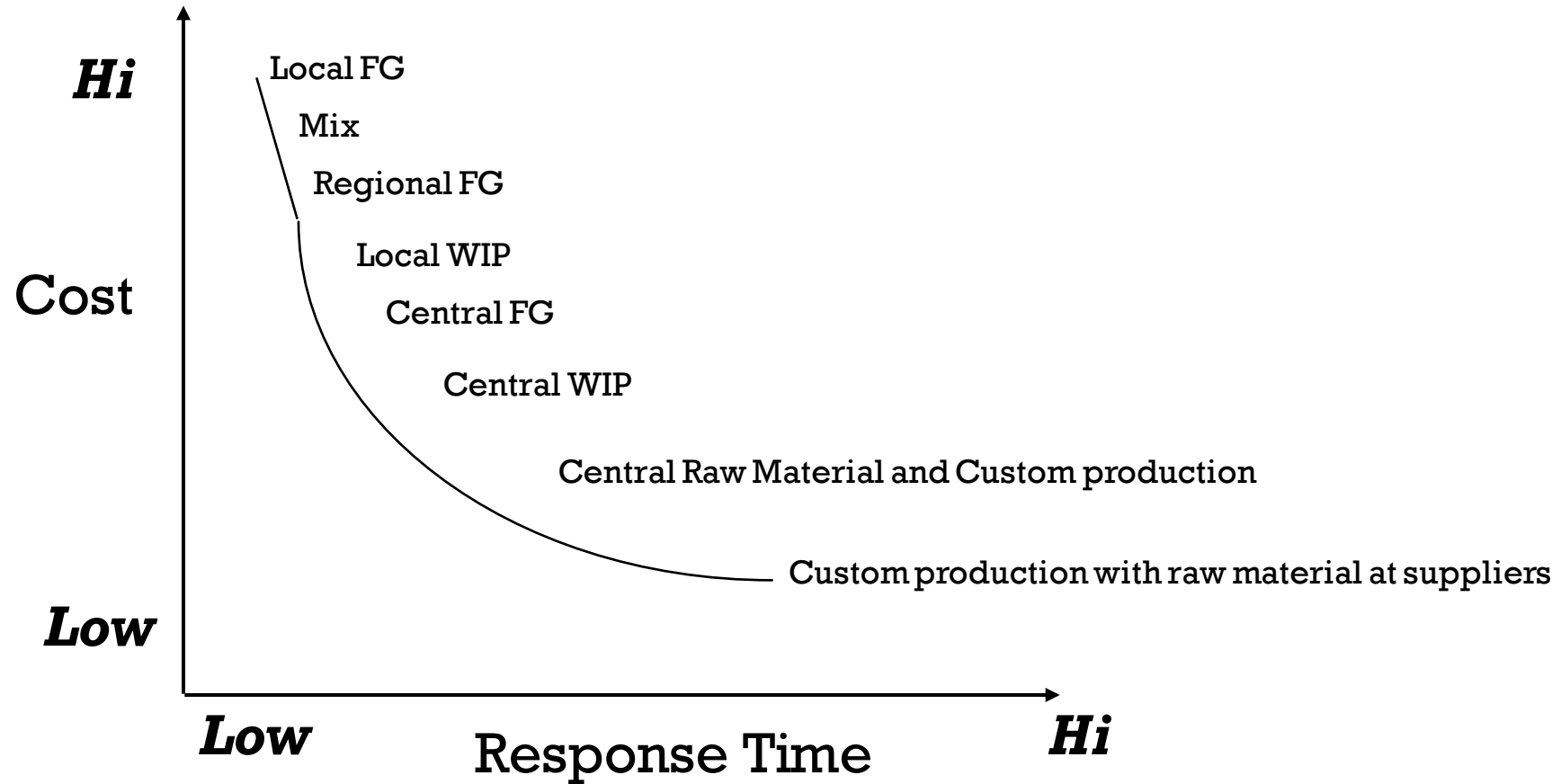


8. Logistics and facility cost

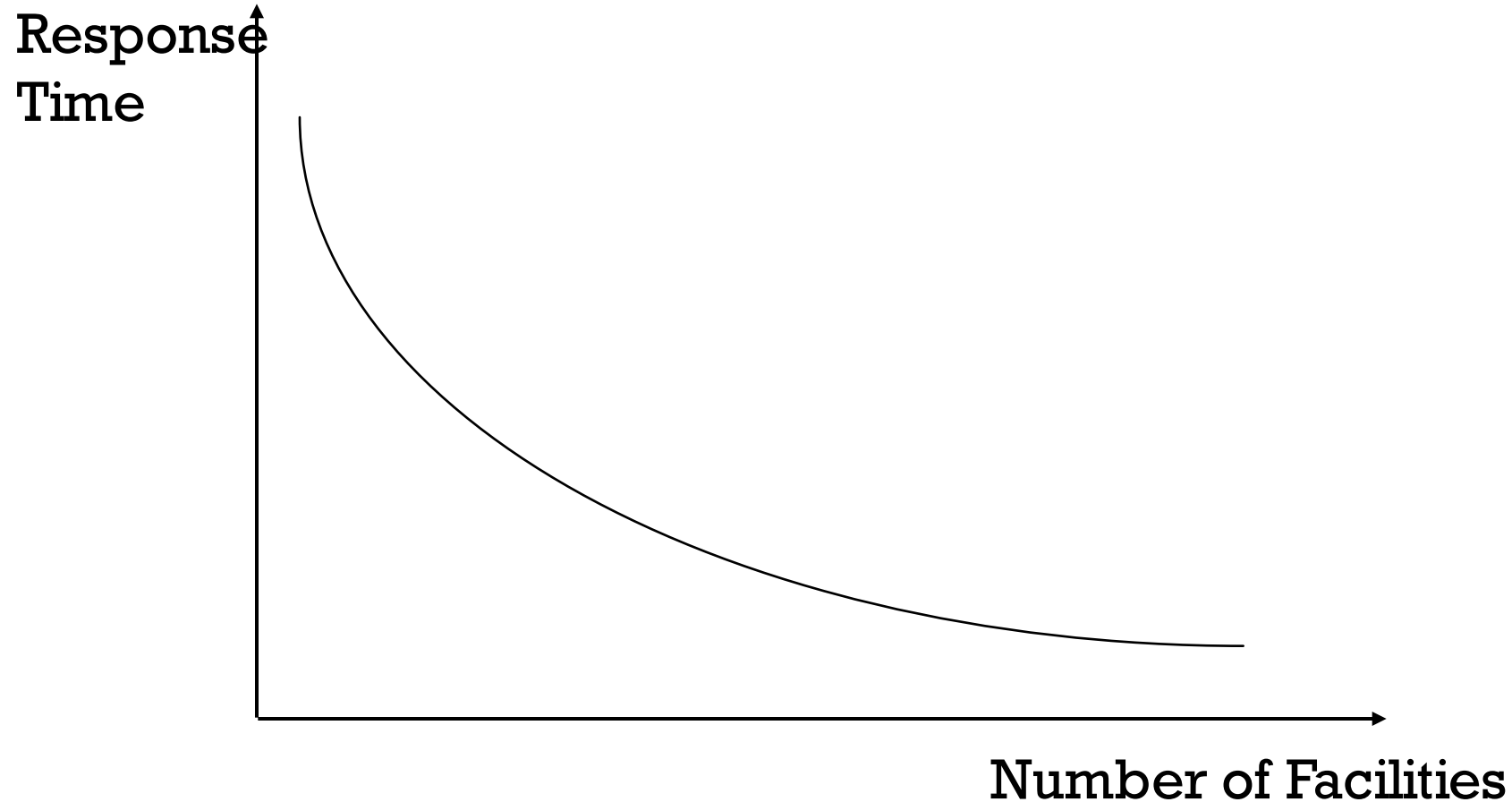
- These costs incurred in the supply chain as the number of facilities, their location, and capacity allocation change.
- Company must consider inventory, transportation, and facility cost when designing their supply chain networks.



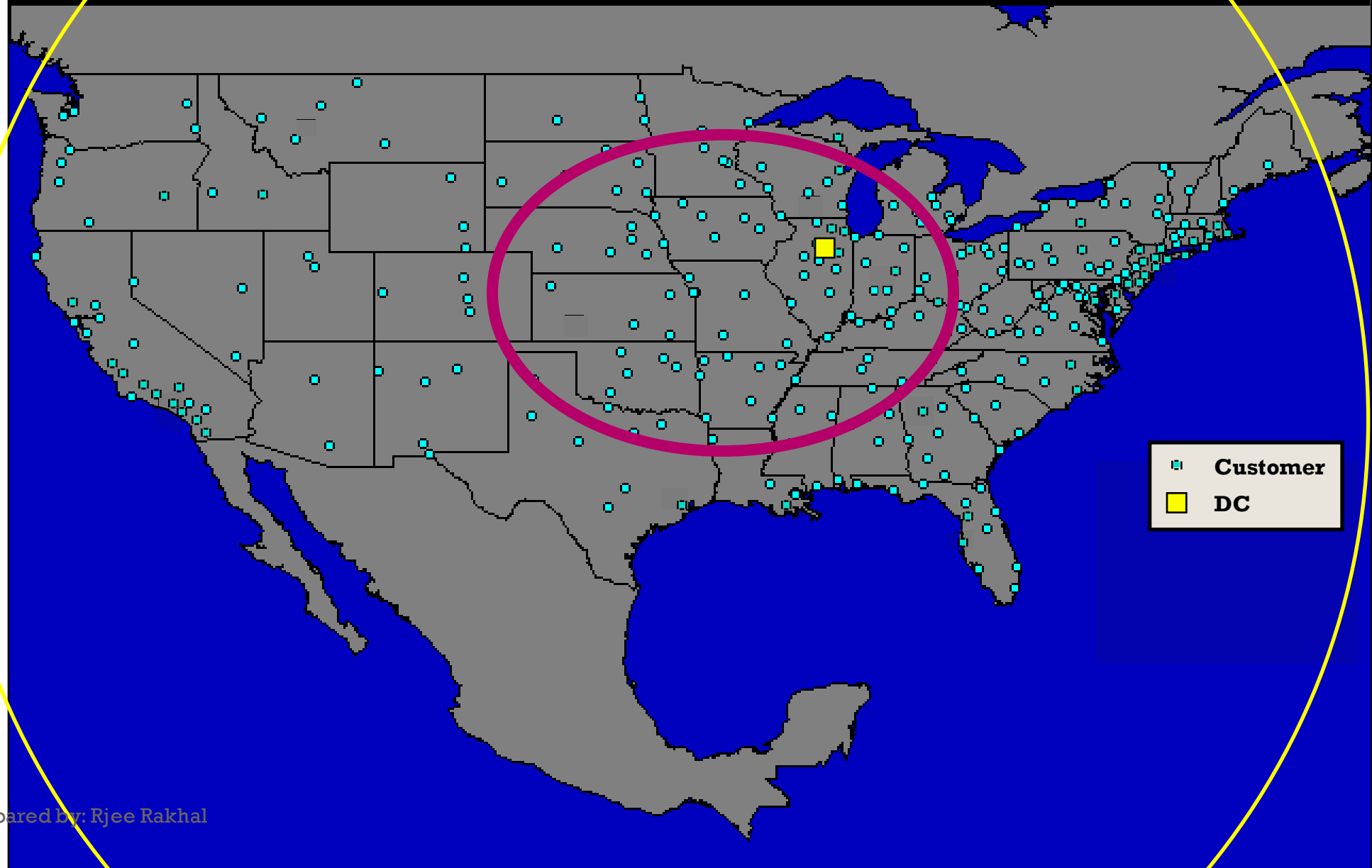
THE COST-RESPONSE TIME FRONTIER



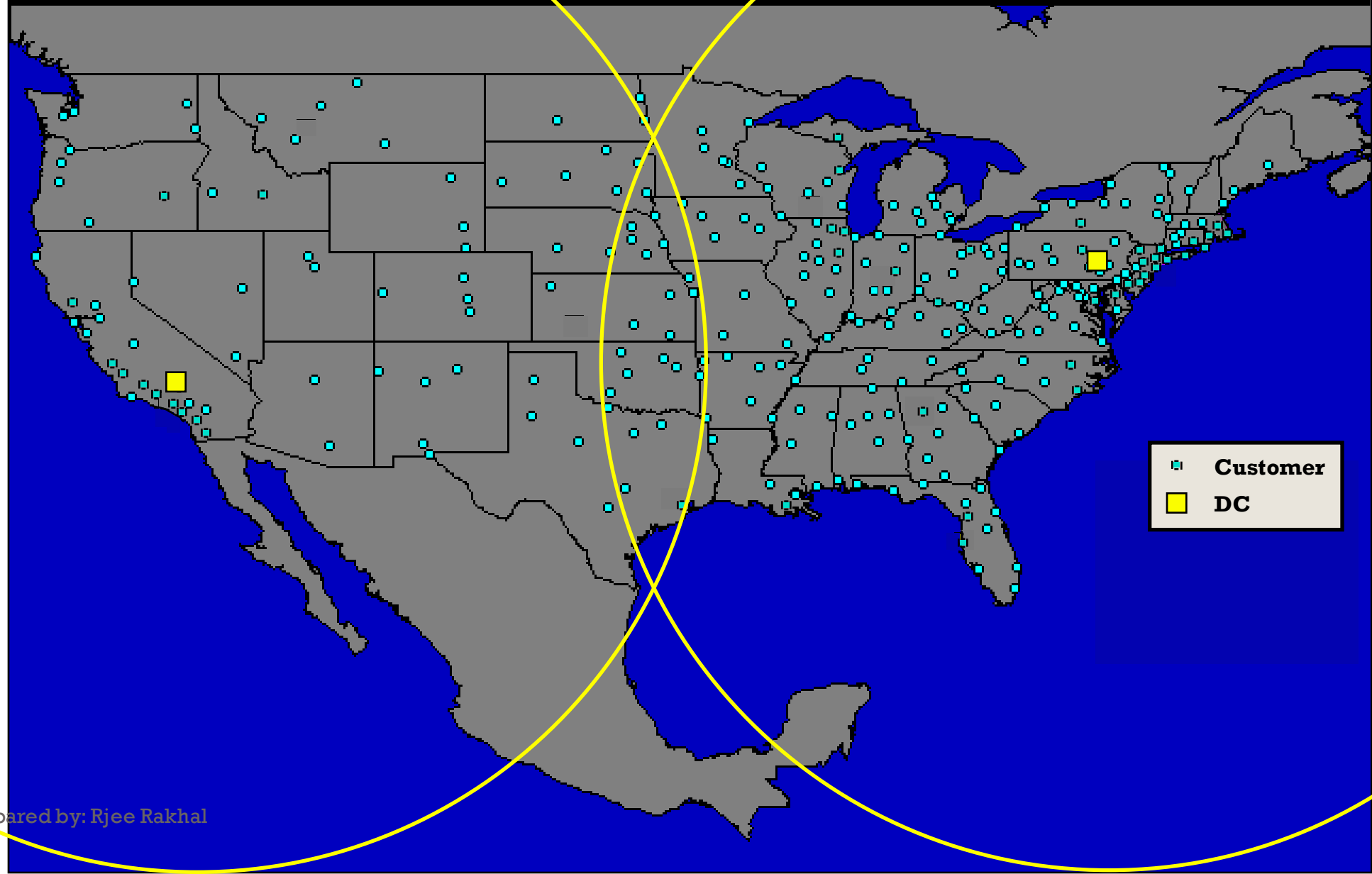
SERVICE AND NUMBER OF FACILITIES



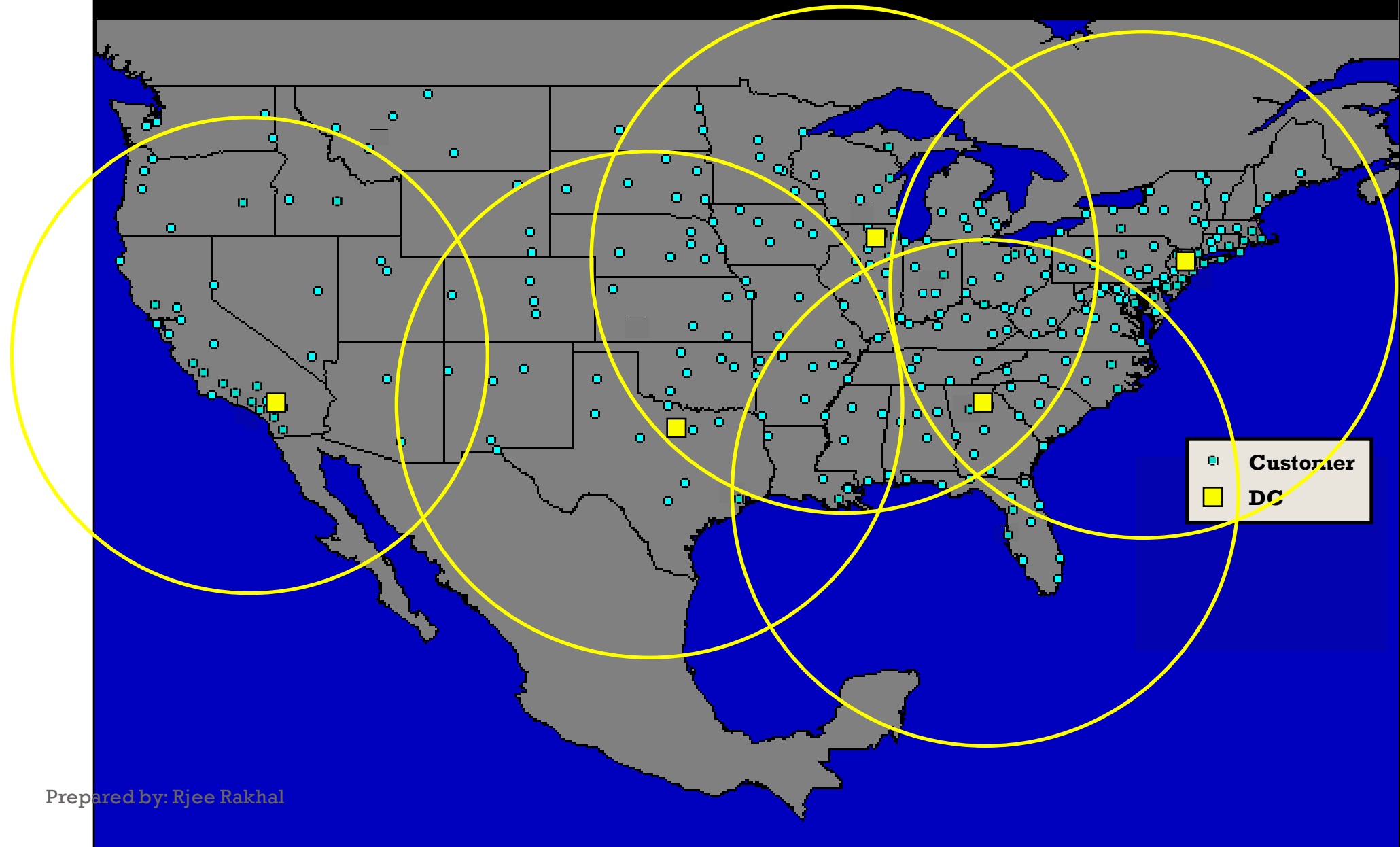
Where inventory needs to be for a one week order response time - typical results --> 1 DC



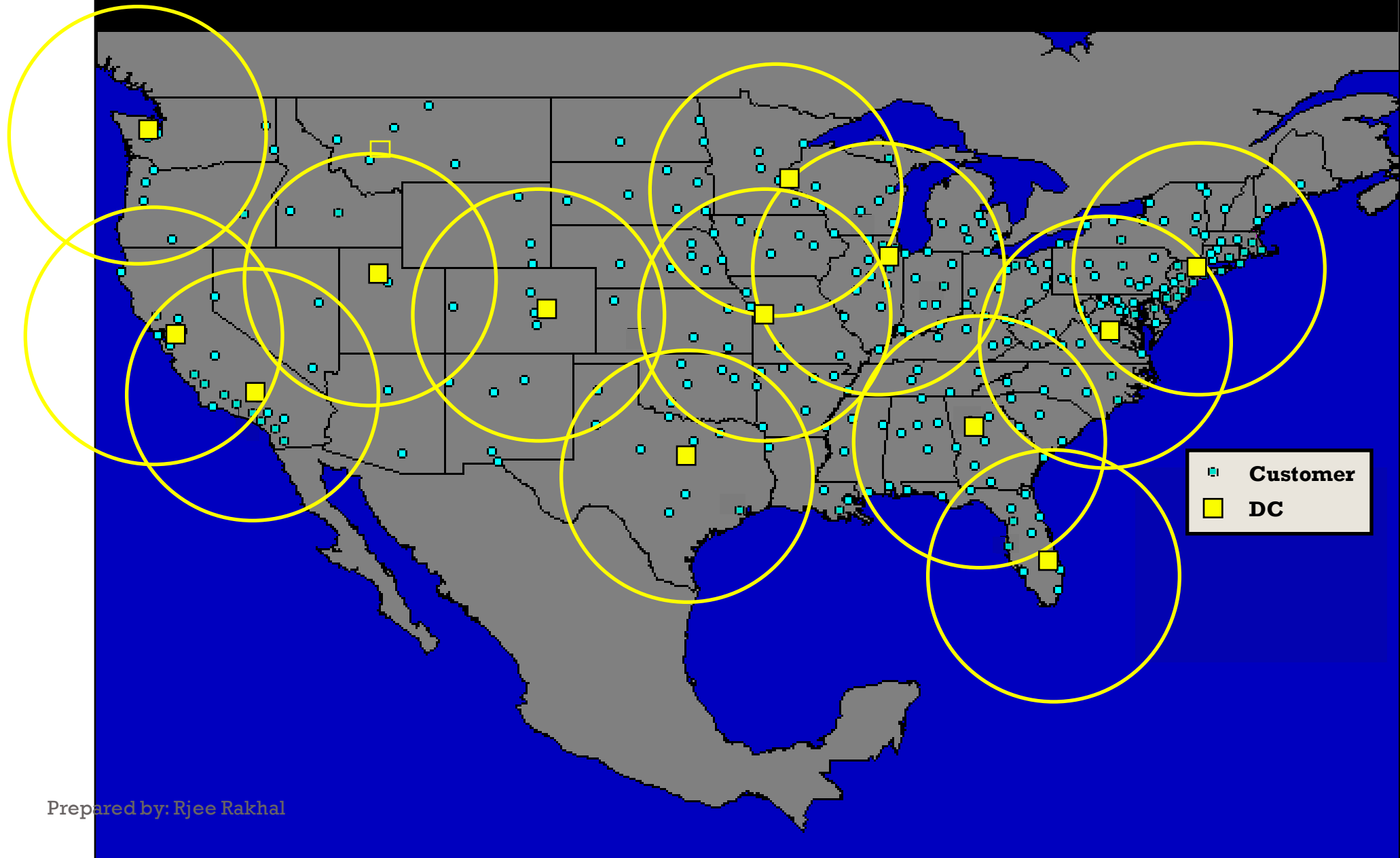
**Where inventory needs to be for a 5 day order response time - typical results -->
2 DCs**



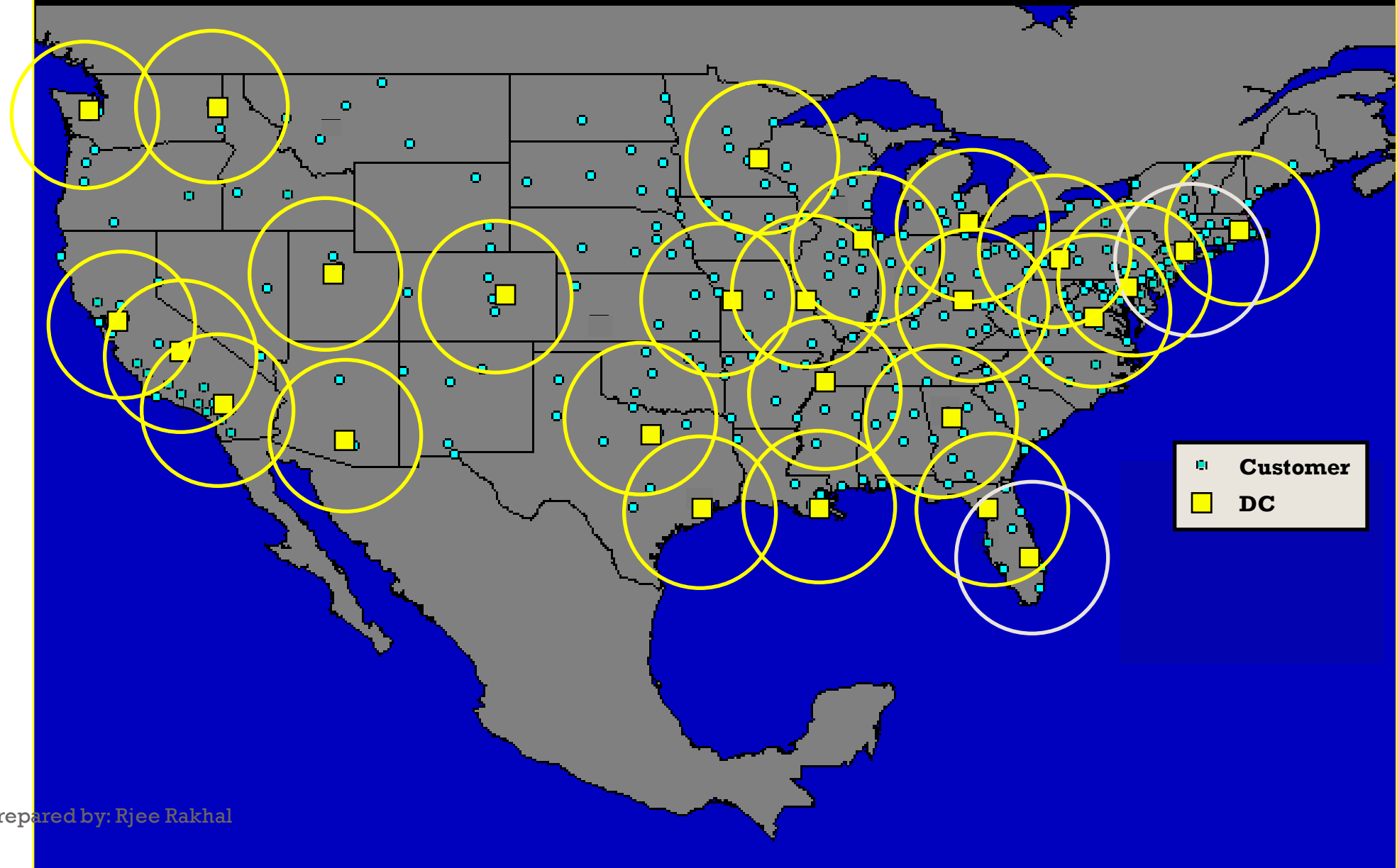
Where inventory needs to be for a 3 day order response time - typical results --> 5 DCs



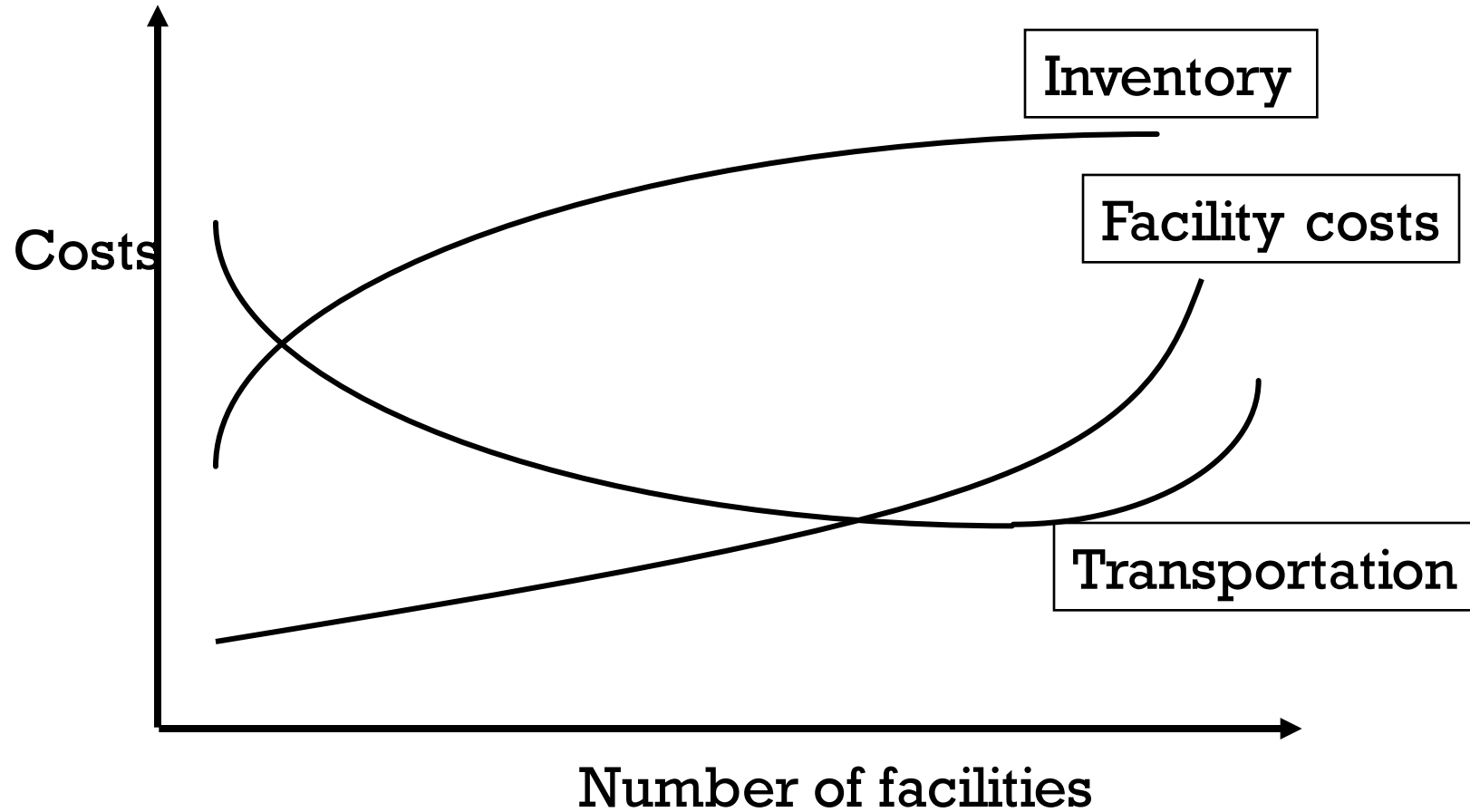
Where inventory needs to be for a next day order response time - typical results --> 13 DCs



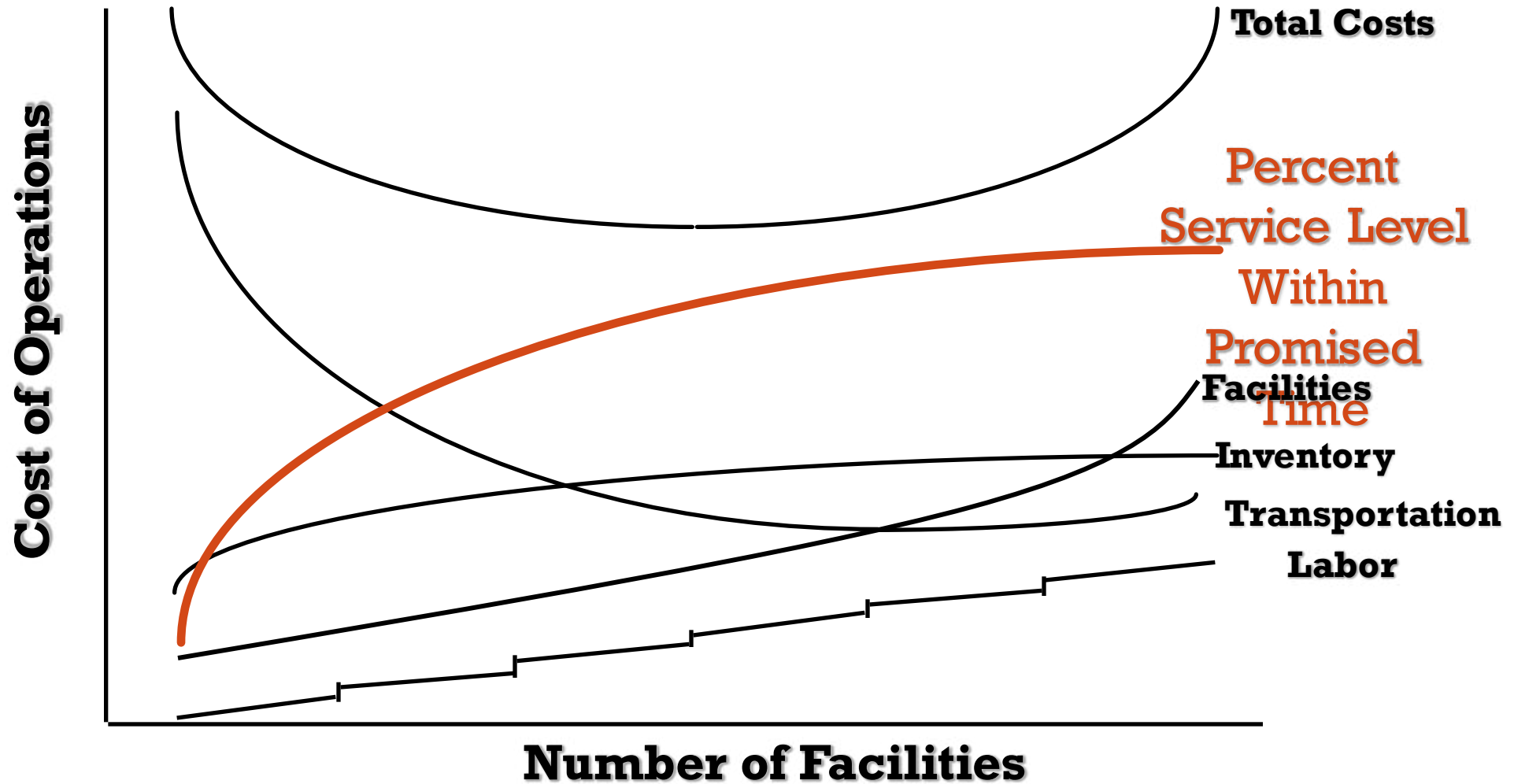
**Where inventory needs to be for a same day / next day order response time -
typical results --> 26 DCs**



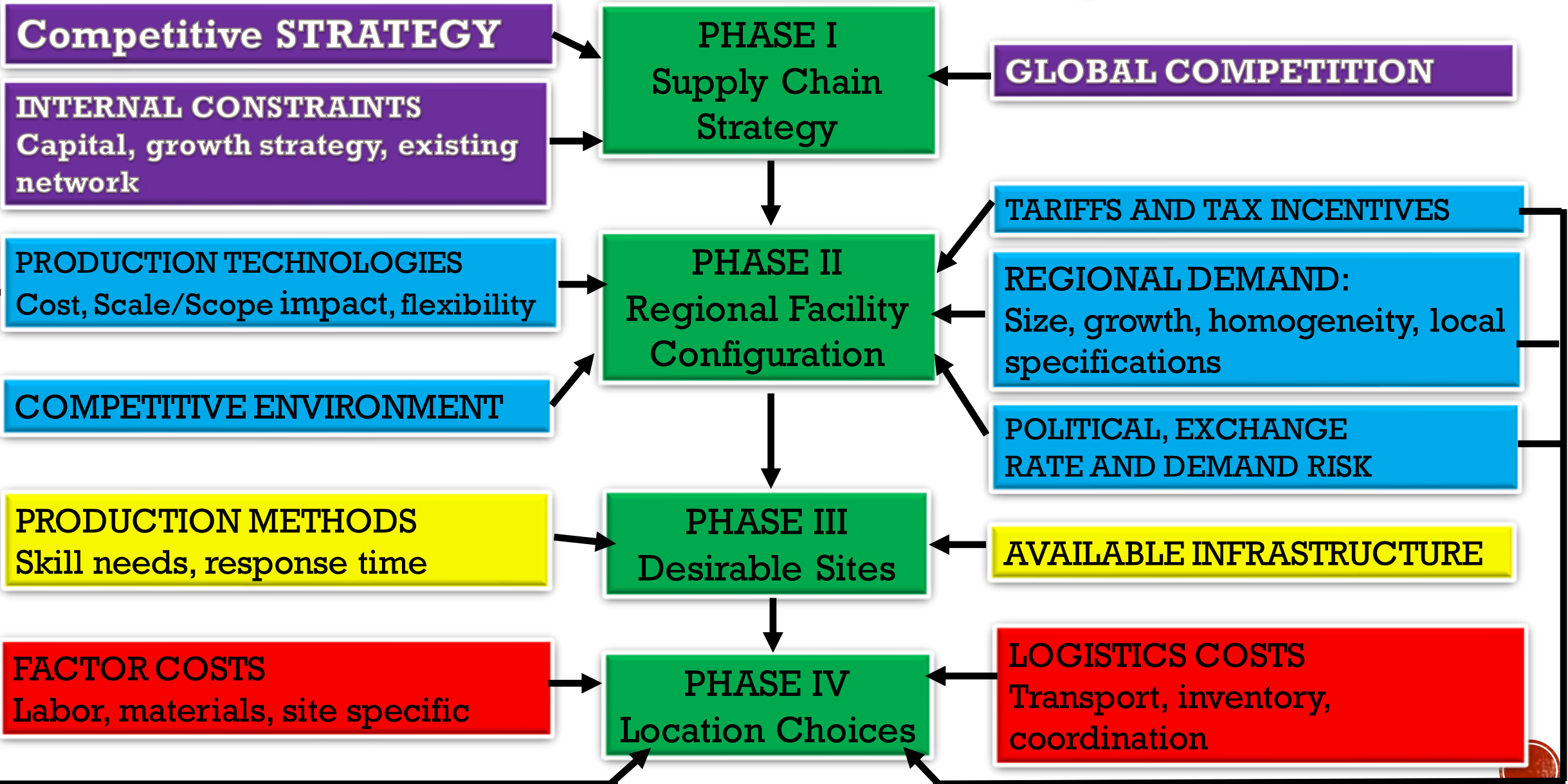
COSTS AND NUMBER OF FACILITIES



Cost Buildup as a Function of Facilities



A Framework for Network Design Decision



Phase I: Design a Supply Chain Strategy –

- Starts with a clear definition of the firm's competitive strategy as the set of customer needs that the supply chain aims to satisfy.
- Managers must forecast the likely evolution of global competition and whether competitors in each market will be local or global players.
- Constraints on available capital and whether growth will be accomplished by acquiring existing facilities or building new facilities



Phase II: Define the Regional Facility Configuration

- Forecast of the demand by country. Include a measure of the size of the demand as well as a determination of whether the customer requirements are homogenous or variable across different countries.
- Homogenous requirements favor large consolidated facilities whereas requirements that vary across countries favor smaller, localized facilities.
- If economies of scale are significant in reducing costs, it may be better to have few facilities serving many markets. If economies of scale are not significant, it may be better for each market to have its own facility.
- They must identify demand risk, exchange rate risk, political risk, tax incentives and regional tariffs for local production. They must also decide whether a facility needs to be located close to or far from a competitor's



Phase III: Select a Set of Desirable Potential Sites —

- **Hard infrastructure** requirements include the availability of suppliers, transportation services, communication, utilities and warehousing infrastructure.
- **Soft infrastructure** facilities include the availability of skilled workforce, workforce turnover and the community receptivity to business and industry.

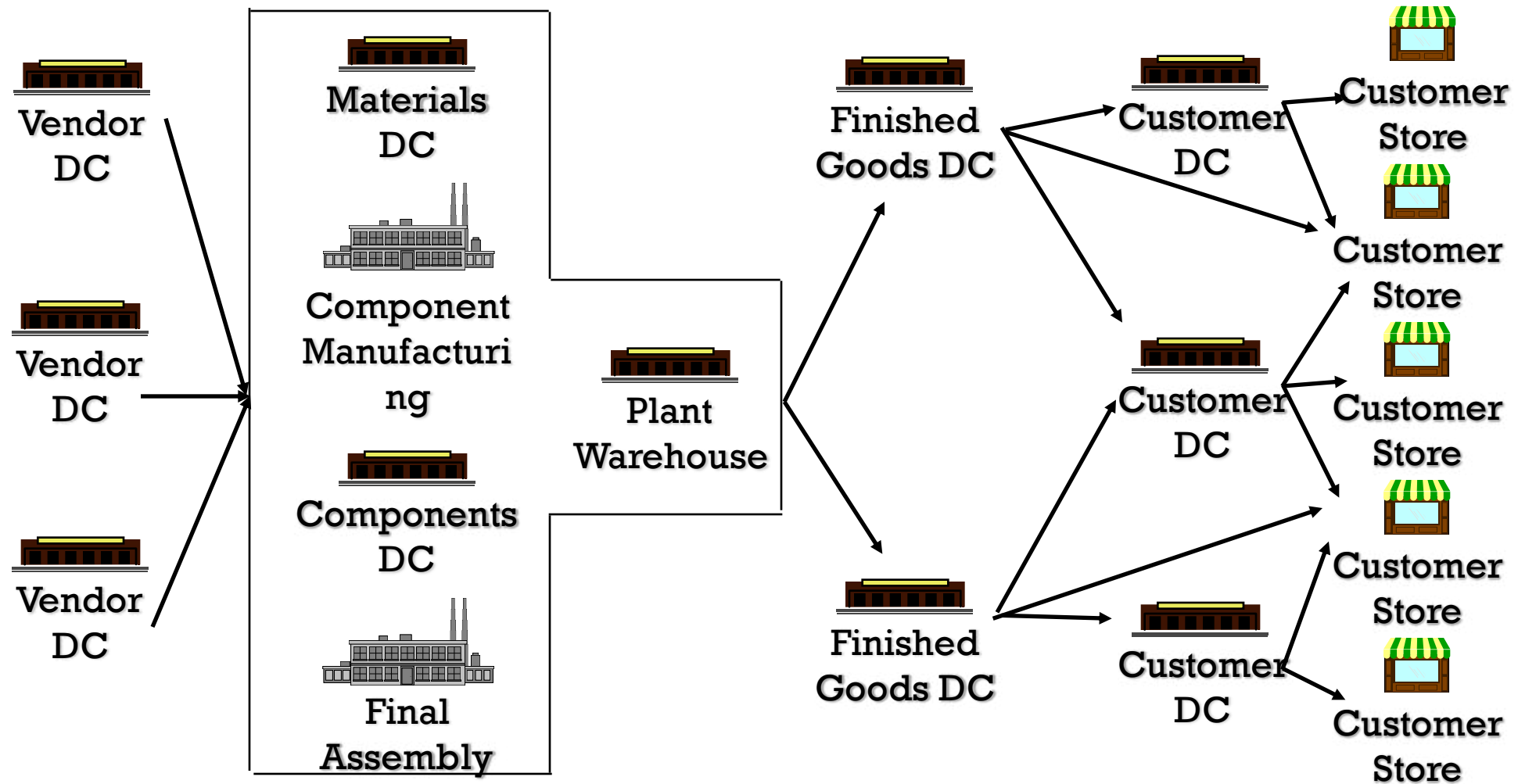


Phase IV: Location Choices –

- Maximize total profits taking into account the expected margin and demand in each market, various logistics and facility costs, and the taxes and tariffs at each location.



Conventional Network



Thank you!!!

