

CPIM

CERTIFIED IN PLANNING
AND INVENTORY MANAGEMENT

MODULE 8: DISTRIBUTION

Distribution

- Section A: Planning Distribution
- Section B: Replenishment
- Section C: Order Management, Trace/Track, and KPIs

CPIM CERTIFIED IN PLANNING AND INVENTORY MANAGEMENT

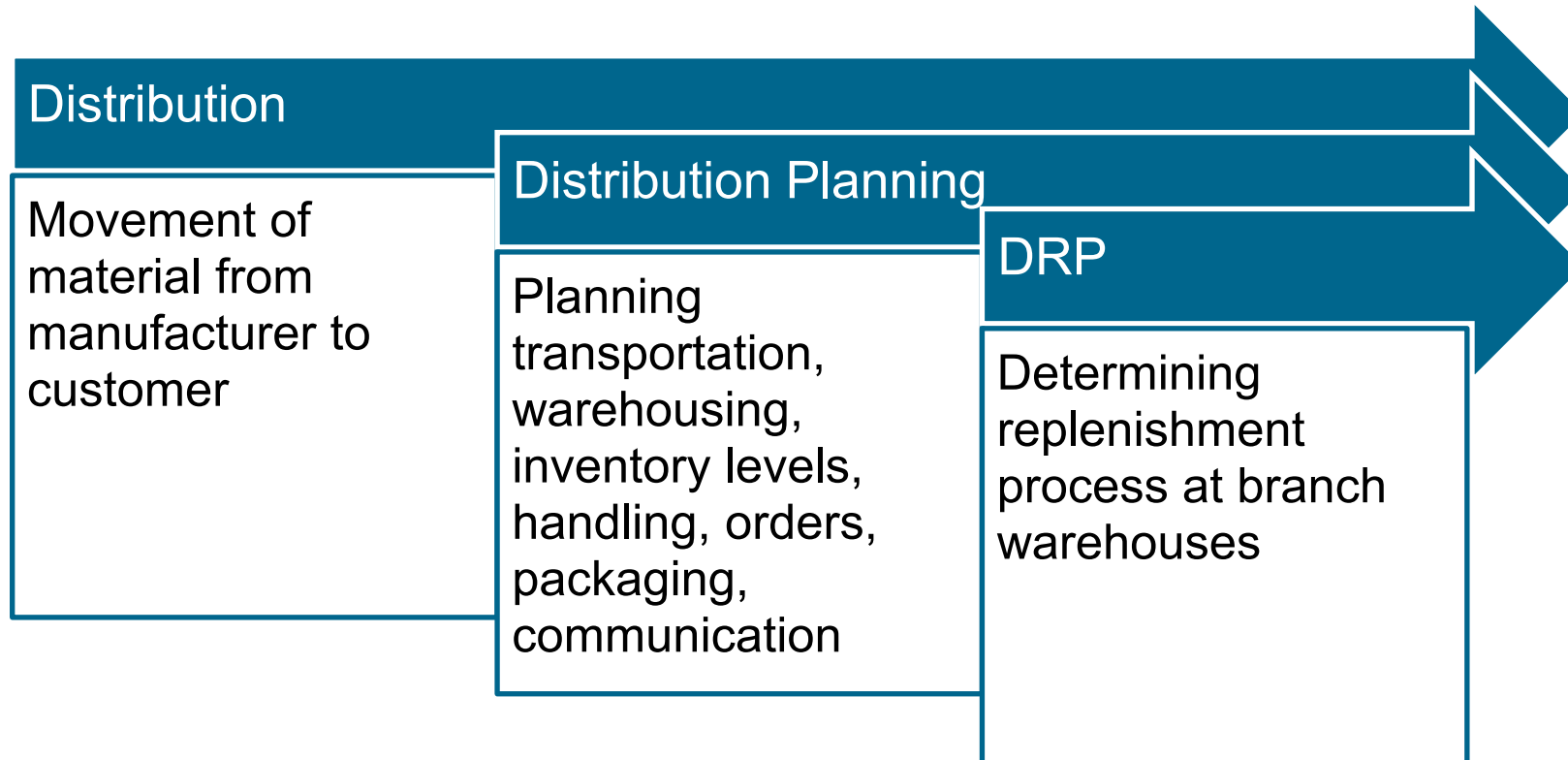
SECTION A: PLANNING DISTRIBUTION

Section A Learning Objectives

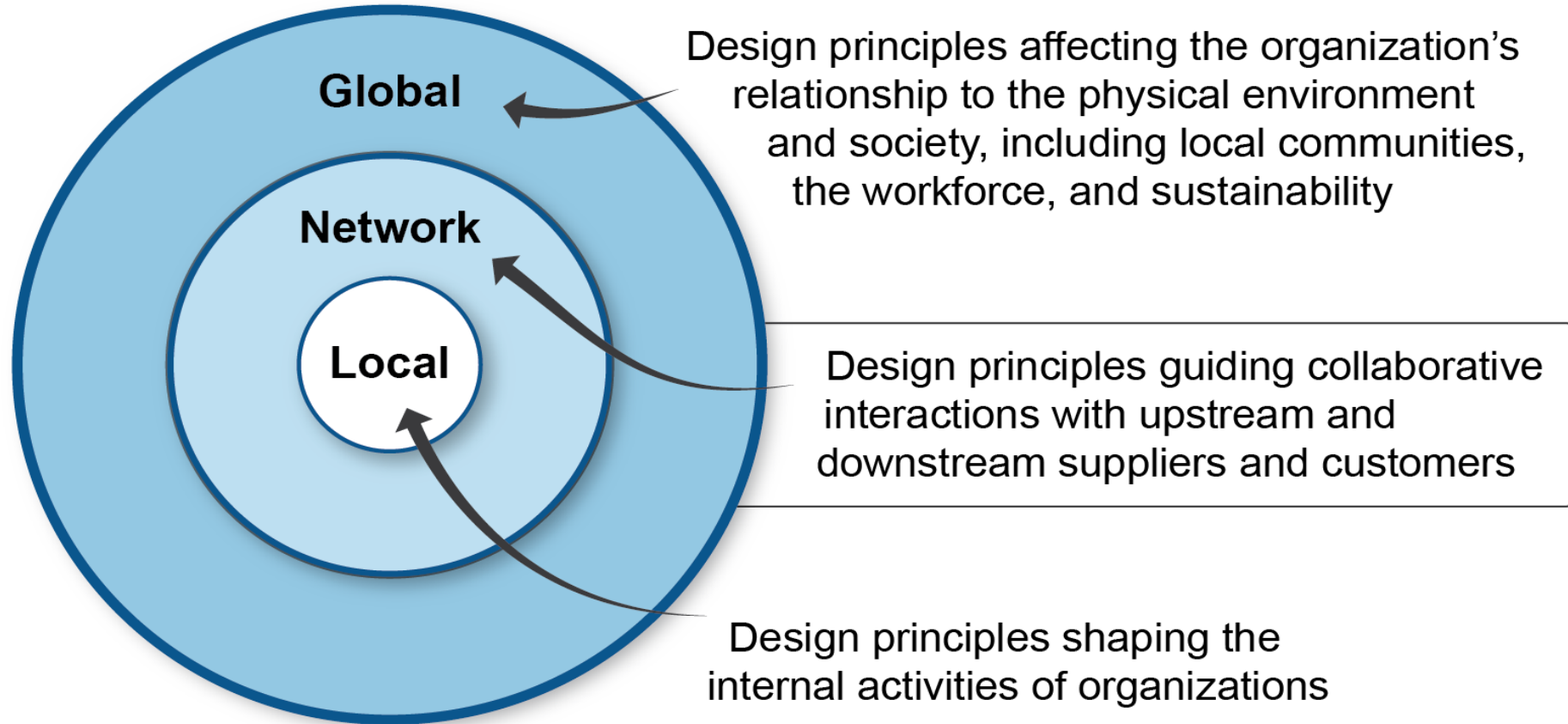
- Distribution inventory planning objectives
- Network configurations
- Shipping costs and rates
- Distribution center locations and inventory levels
- Tradeoffs
- Network transformation process reflecting requirements, as-is, and to-be
- Size and number of DCs
- Order channels, order fulfillment channels, distribution networks, and order fulfillment channels

Distribution and Inventory Planning

Distribution and Related Terms



Network Design Principles



Design Considerations and Principles

Logistics principles

- Physical proximity
- Transportation considerations and modes
- Tracking capabilities

Network design principles

- Ensuring dependability of intermediaries
- Establishing collaborative relationships



Distribution Inventory Planning System Objectives

Targeted level of customer service at each stockkeeping location

- Central supply may hold all types of inventory while regional DCs vary what they carry (demand patterns).

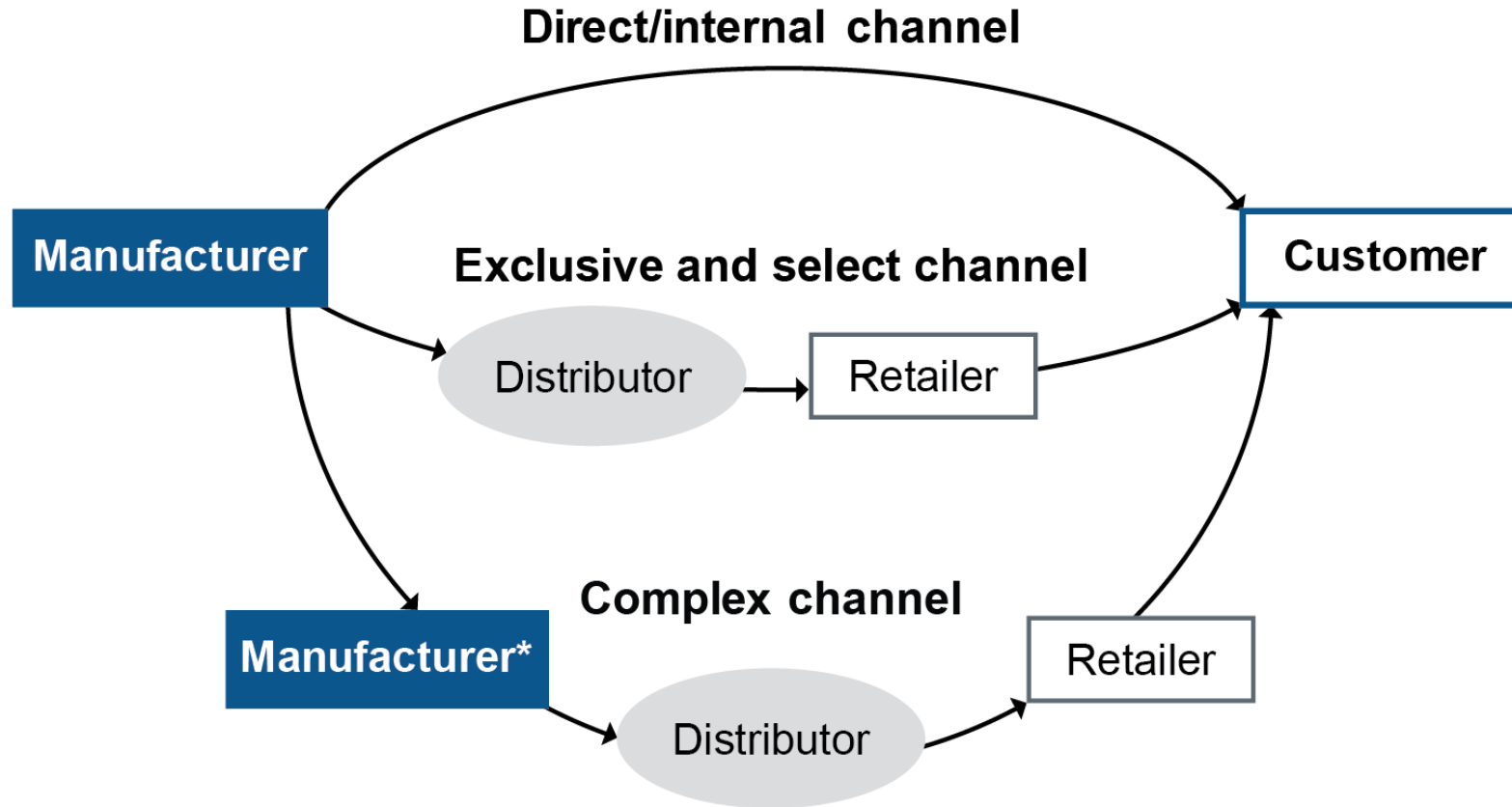
Smoothest interaction with supply chain partners

- Minimize scheduling problems.
- Communicate reasons for larger or smaller orders.

Targeted service at lowest cost

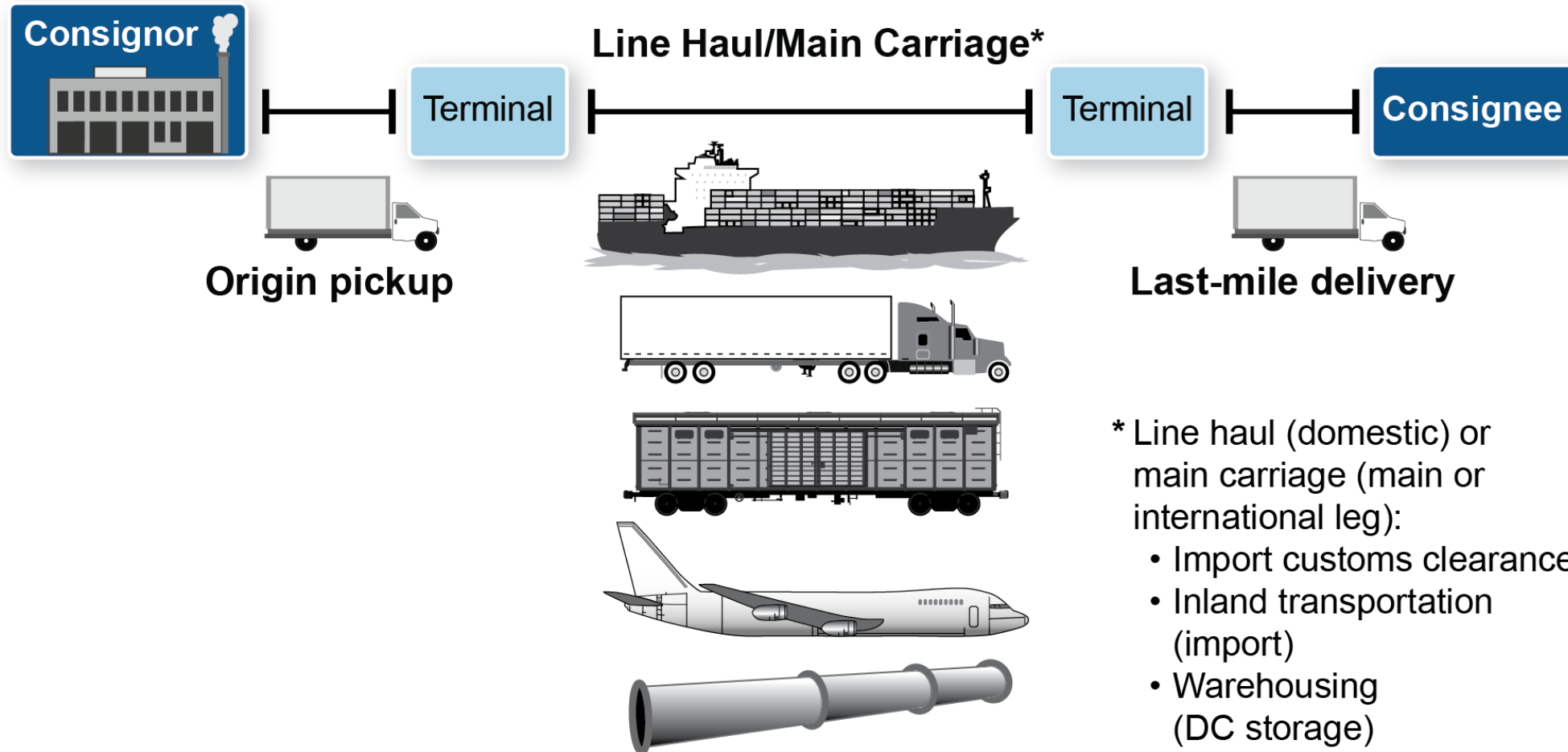
- Minimize materials handling (number of times handled).
- Maximize turnover, e.g., cross-docking.

Distribution Planning Strategy



* Regional distribution centers owned by manufacturer

Shipping Patterns



- * Line haul (domestic) or main carriage (main or international leg):
- Import customs clearance
 - Inland transportation (import)
 - Warehousing (DC storage)

Shipping Costs

Line haul or main carriage

- Costs for main portion of transportation journey
- Includes drivers' wages and usage depreciation

Pickup and delivery (origin pickup and last-mile delivery)

- Charges for shipment pickup and weight
- Depends on weight and number of pickups

Terminal-handling

- Fees for materials handling, inspections, and customs
- Dependent on number of times shipment is handled

Billing and collecting

- Fixed administrative costs
- Fewer shipments or pickups reduce costs

TL Versus LTL and Other Factors Influencing Rates

- Two basic rate structures
 - Truckload (TL or FTL) or mode equivalent: lower rate
 - Quantity discount but lot-size inventory
 - Less-than-truckload (LTL) or equivalent: higher rate
 - More terminal handling, materials handling, billing, trips
- Dangerous goods (hazmat), perishable, frozen, high value, fragile (packaging mitigates), cumbersome
- Low density (max volume), very dense (max weight)
- Backhauling, expediting

Network Configuration

Shipping Exercise

Data

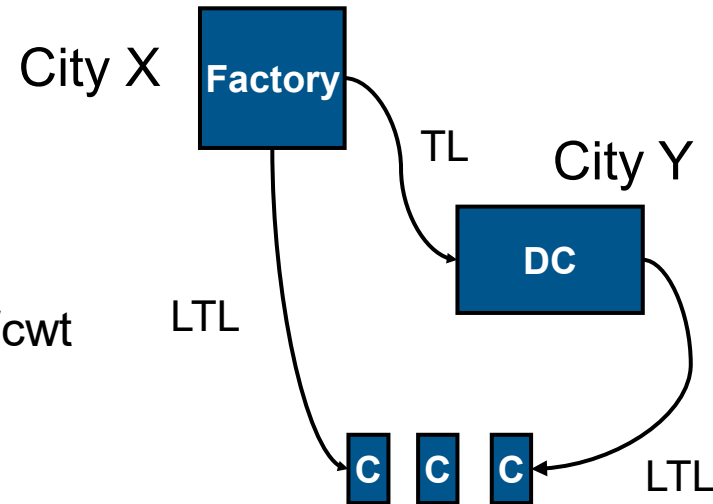
Estimated annual shipped volume = 10,000 cwt

Cost of LTL shipments direct to customers = \$80/cwt

Cost of TL shipments to DC = \$40/cwt

Cost of carrying inventory at DC = \$8/cwt

Cost of local delivery = \$16/cwt

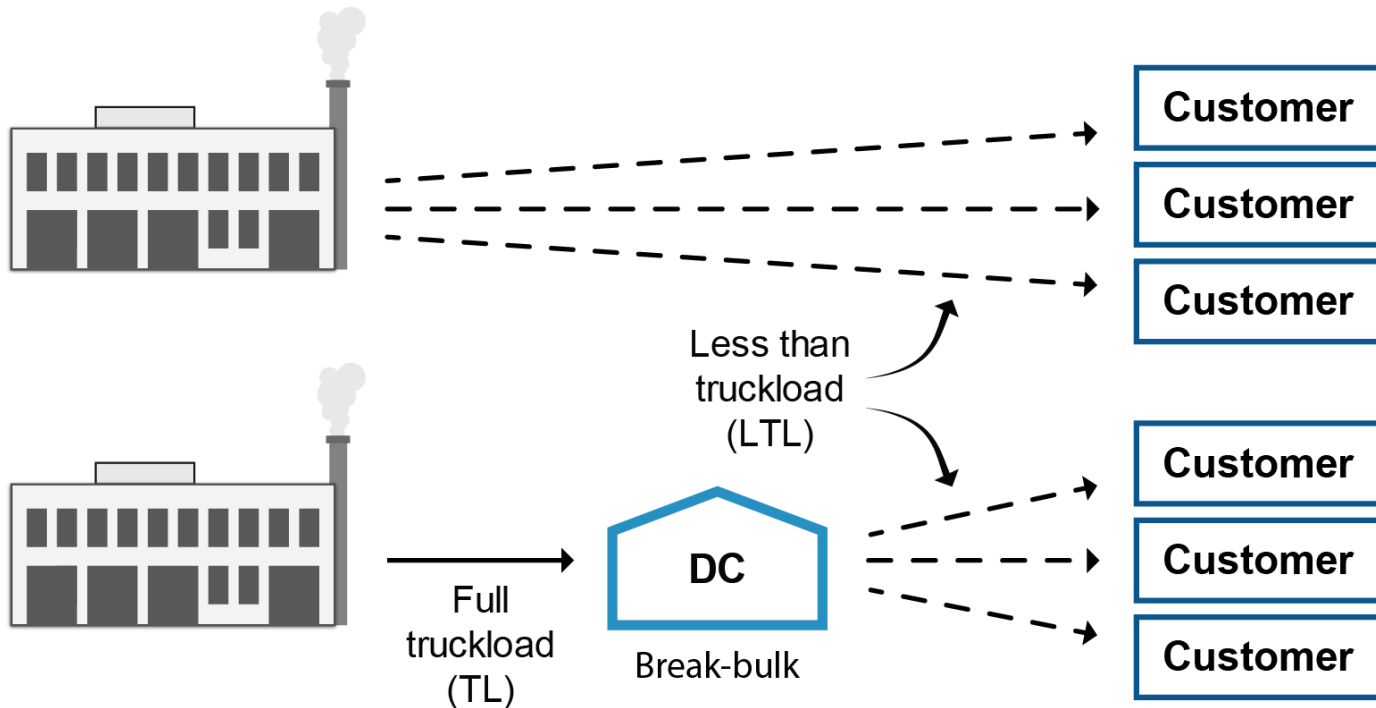


Estimated annual shipment volume =	10,000 cwt
Total annual cost of shipments direct to customers (\$80/cwt) =	\$800,000
Cost of full-truckload shipments to DC (\$40/cwt) =	\$400,000
Cost of carrying inventory at DC (\$8/cwt) =	\$80,000
Cost of local delivery (\$16/cwt) =	\$160,000
Total annual distribution costs to customers through DC =	\$640,000

Network Configuration

How Warehousing Can Reduce Transportation Costs

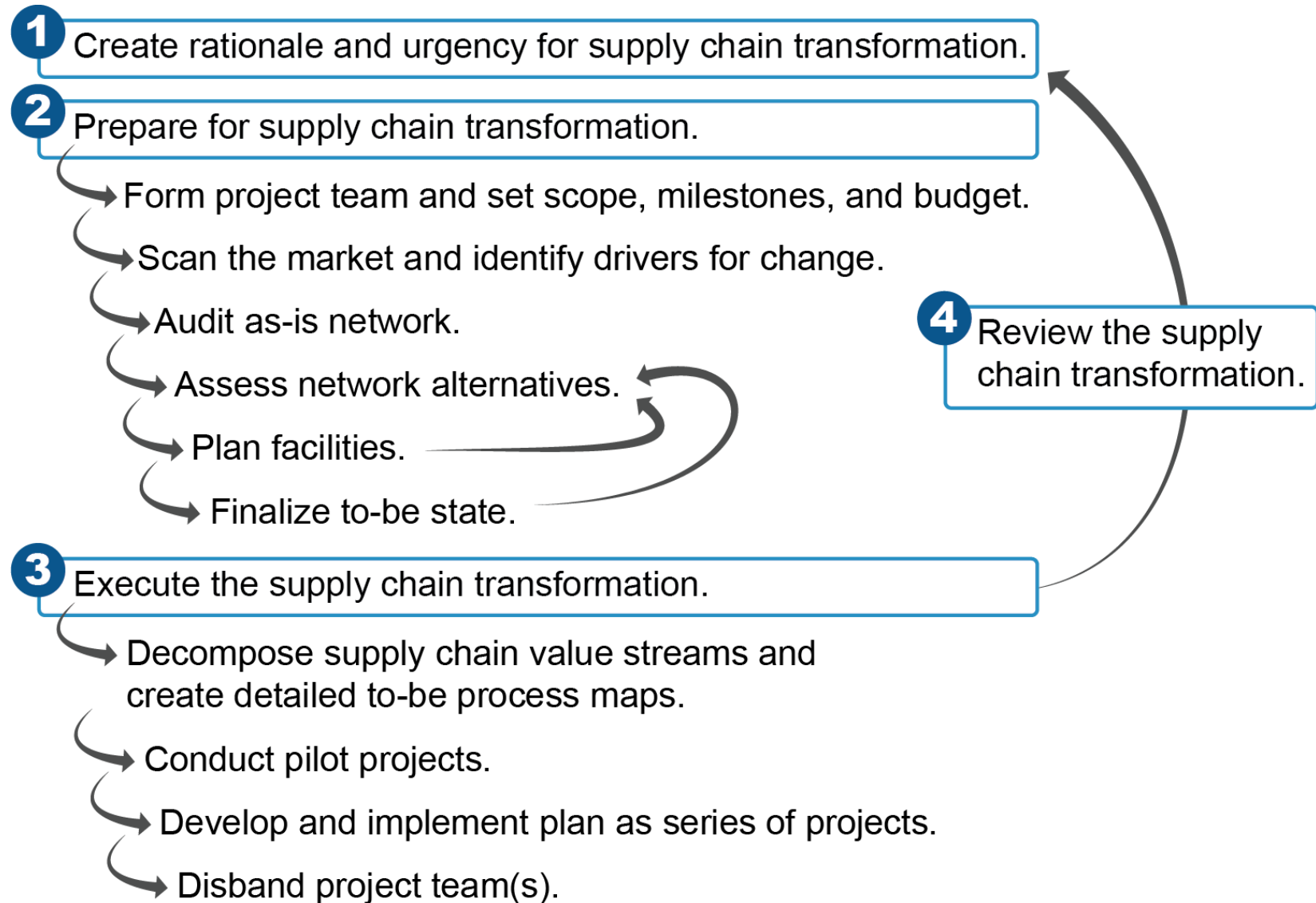
- Value-added role: break-bulk, freight consolidation.
- Warehouses cost money.



Annual Volume (Tons)	40,000	
LTL Direct per Ton	\$100	\$4,000,000
Total Cost LTL Direct	\$100	\$4,000,000
TL to DC Line Haul per Ton	\$50	\$2,000,000
Pickup and Delivery per Ton	\$10	\$400,000
DC Carrying Cost per Ton	\$12	\$480,000
Total Cost TL with DC	\$72	\$2,880,000
Difference	\$28	\$1,120,000

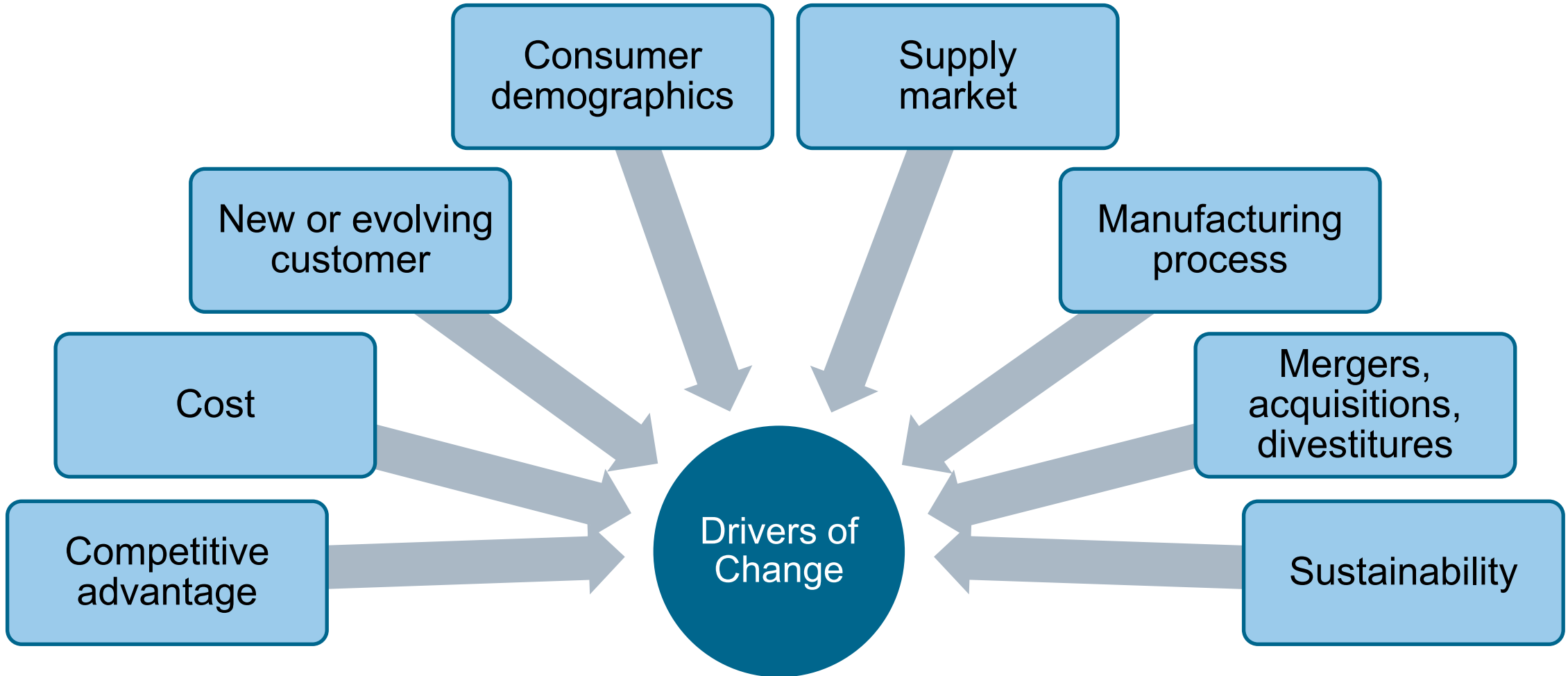
Design or Redesign a Logistics Network

Design Process



Design or Redesign a Logistics Network

Common Drivers of Change



Design or Redesign a Logistics Network

As-Is Audit Steps

Gather data and business information.

Map current system (e.g., nodes and links).

Describe key activities and functions.

Measure against benchmarks.

List gaps between actual and strategy.

Generate tactical plans for closing gaps.

Design or Redesign a Logistics Network

As-Is and To-Be Maps



- Warehouse
- Customer
- Supplier
- Days of inventory at location

Evaluate Network and Transportation Requirements

Design Supply Chain Strategy with End in Mind

Low-cost

Cost: superior; **assets** and **reliability:** advantage; parity for rest

Customer with high demand variability

Agility: superior; **responsiveness** and **reliability:** advantage; **efficiency areas:** parity

Project-driven customers

Reliability: superior; **agility** and **responsiveness:** advantage; **efficiency areas:** parity

Customer-supplier long-term partnership

Profit: superior; **reliability** and (for example) **sustainability:** advantage; parity for rest

Customers needing innovative or emergency capacity

Agility: superior; **responsiveness** and **assets:** advantage; parity for rest

Determine Servicing Expectations



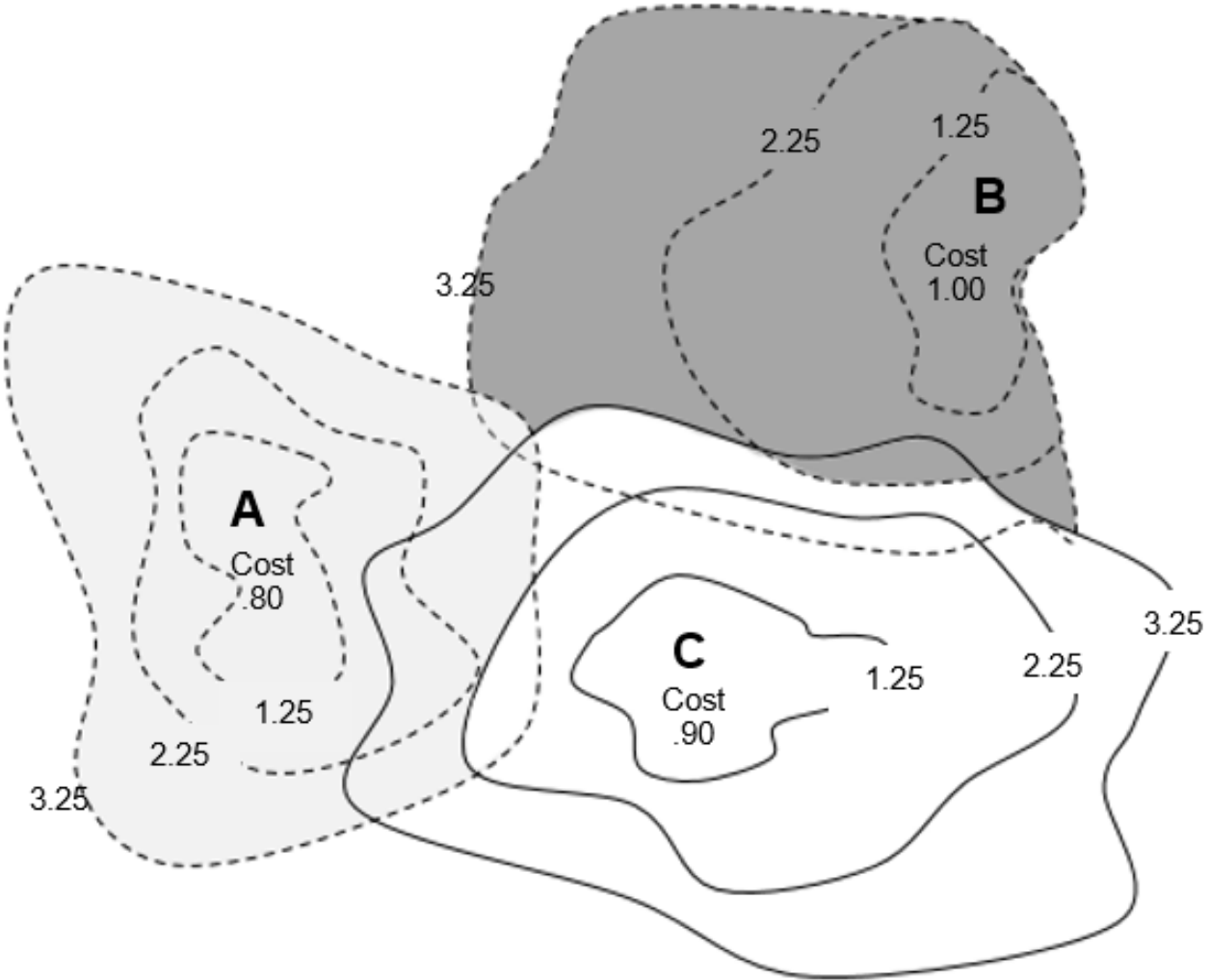
Why is information on customers' acceptable lead times or network servicing frequency so important to network design?

Answer:

Dictates number of distribution centers (DCs) that will be needed.

Evaluate Network and Transportation Requirements

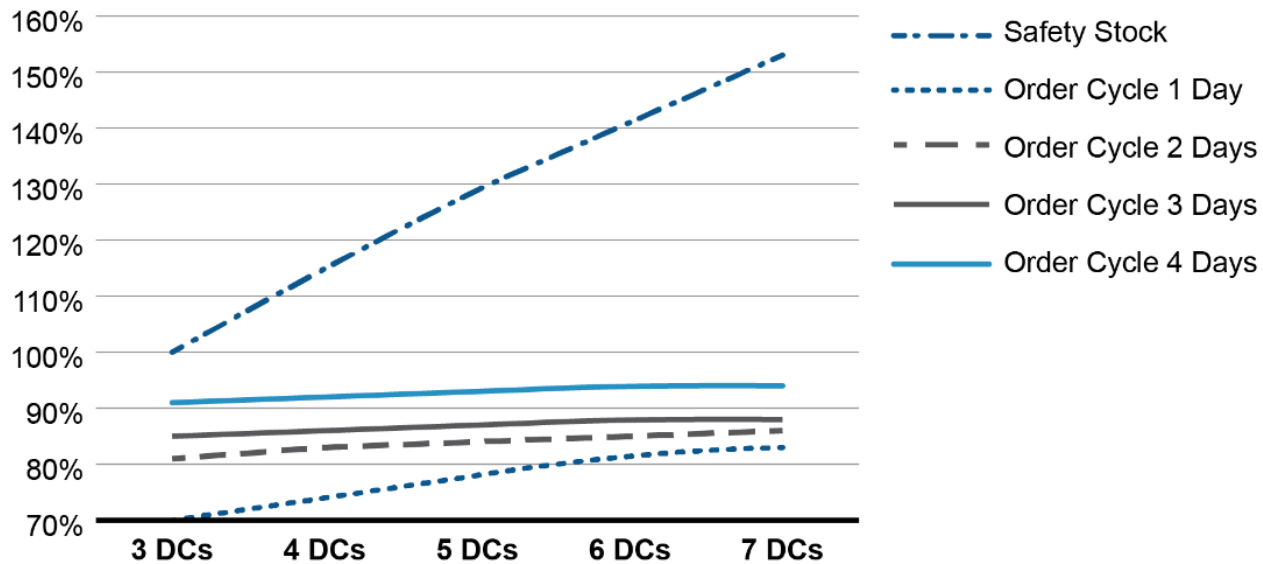
Economic Cost Map



Evaluate Network and Transportation Requirements

Sensitivity Analysis

Order Cycle Durations More Reliable with More DCs



Maister's Square Root Rule

- New Aggregate Safety Stock

$$= \sqrt{\frac{\text{Future Total DCs}}{\text{Existing DCs}}} \times \text{Existing Aggregate Safety Stock}$$

- From 3 to 4 DCs = $\sqrt{\frac{4}{3}} \times 100\% = 115\%$

Transportation Requirements Analysis

Average shipments per period. Inputs:

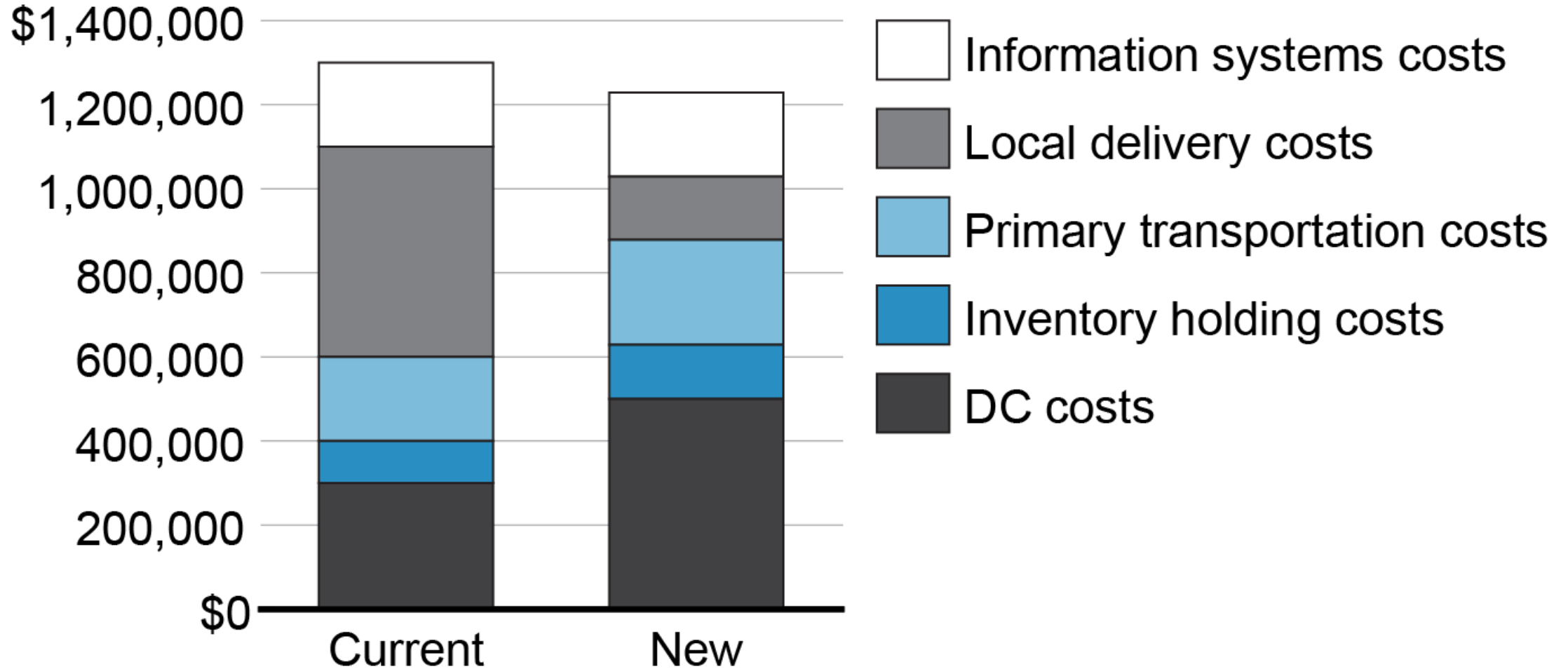
- Product family demand forecast
- Sales and marketing commitments

Aggregate network transportation requirements. Can break down:

- Requirements per mode with average rates
- Estimated proportion of full and partial loads
- Primary transportation and local delivery segments
- Lane volumes

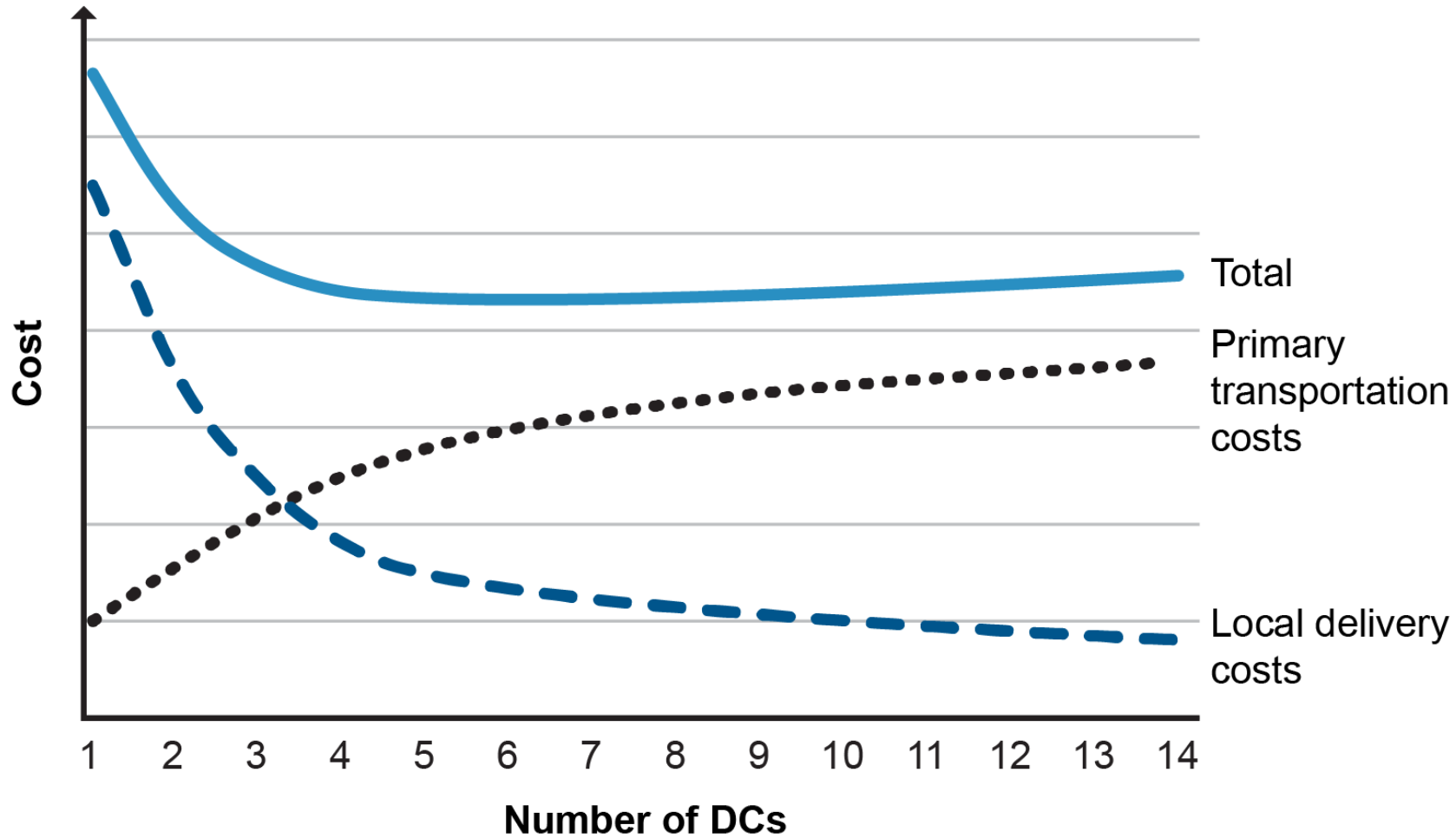
Evaluate Network and Transportation Requirements

Tradeoff Analysis



Evaluate Network and Transportation Requirements

Tradeoffs



Impact of DC Locations on Inventory Levels

- Adding locations doesn't impact cycle stock.
- Safety stock rises, but rate slows.
 - Shorter outbound order cycle time, less variability, less need for safety stock.
- Less in-transit inventory.
- Increased inbound order cycle time and in-transit time.
- Average Aggregate Inventory =

$$\sum_{i=1}^n \frac{\text{Order Quantity}_i}{2} + \text{Safety Stock}_i + \text{In-Transit Inventory}_i$$


Evaluate Facility Requirements

Types of Distribution Strategies, Distribution Networks, and Order Fulfillment Channels

- Distribution strategy: General goals
- Distribution network: Implementation
- Order fulfillment channel: Specific routes

Evaluate Facility Requirements

Geographical Considerations and Factors



Strategy	<ul style="list-style-type: none">• Capital expense• Location: mission, vision, and organizational strategy
Labor rates	<ul style="list-style-type: none">• Rates and skill availability• Plus long-distance transport cost
Quality	<ul style="list-style-type: none">• Quality may be cultural imperative• Higher labor costs typical
Nation/region incentives	<ul style="list-style-type: none">• Taxes, proximity, incentives, strategic or cultural factors

Make Facility Number and Type Decisions

Deployment Considerations

Proximity

- Weight
- Fuel
- Average lead time
- Demographics

Specialty Types

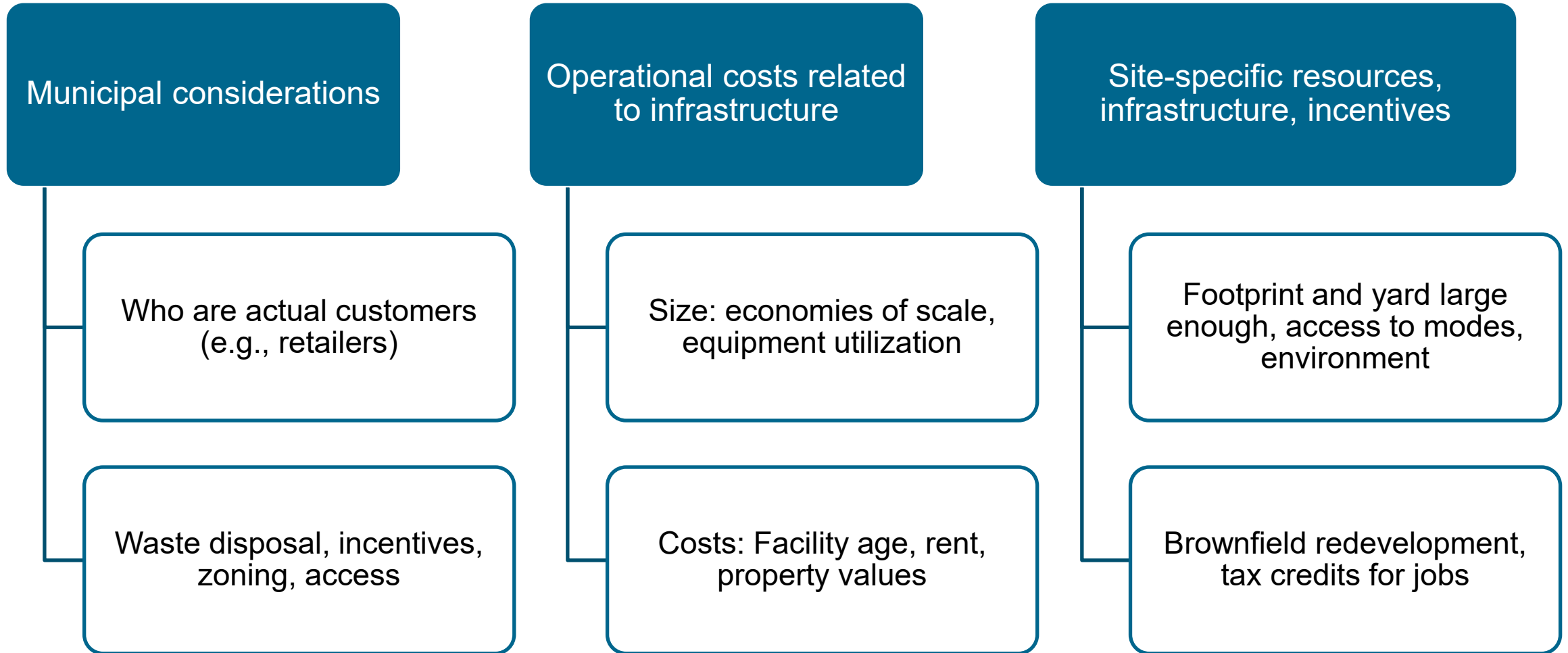
- Dangerous goods (hazmat)
- Reverse logistics
- Cold chain

Viable Alternatives

- E.g., cross-docking versus fulfillment, consolidation, or break-bulk
- Communications robust enough to cross dock?

Make Facility Number and Type Decisions

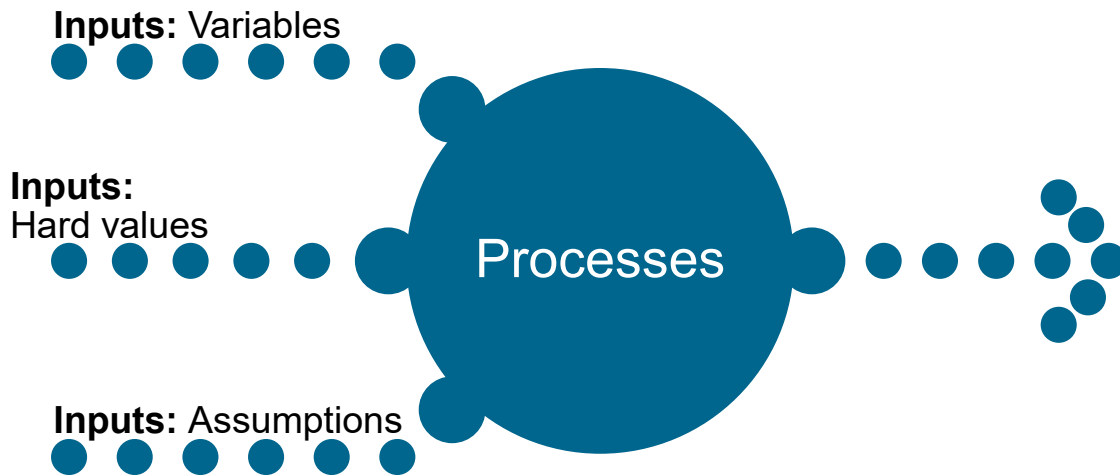
Site-Specific Considerations



Understand Different Network Modeling Approaches

Modeling Basics and Prerequisites

What is a model?



Prerequisites

- Data validation: automate
- Data integrity:
 - ALCOA (attributable, legible, contemporaneous, original, accurate)
 - GIGO
- Complexity and assumptions reviews
- Static or dynamic decision

Understand Different Network Modeling Approaches

Analytics and Heuristics

Analytics



Prescriptive analytics

Predictive analytics

Descriptive analytics

Heuristics

- Problem solving
- Results or rules from experience or intuition (not optimization)
- Experiment to approximate
- Decision rules and math
- Examples:
 - Forecasting
 - Inventory levels
 - Staffing
- AI is disrupting use of heuristics

Understand Different Network Modeling Approaches

Cost-Volume Analysis

- $\text{Total Cost} = \text{Fixed Cost} + (\text{Variable Cost} \times \text{Volume})$

What is the crossover point?

City	Fixed Costs	Variable Costs	Maximum Units	Total Cost at Maximum Units
Denver	\$2,000,000	\$615	26,000	\$17,990,000
Seattle	\$4,000,000	\$385	26,000	\$14,010,000
Los Angeles	\$8,000,000	\$115	26,000	\$10,990,000

Understand Different Network Modeling Approaches

Cost-Volume Analysis Scenario

$$X = \frac{\text{Fixed Cost}_2 - \text{Fixed Cost}_1}{(\text{Variable Cost}_1 - \text{Variable Cost}_2)}$$

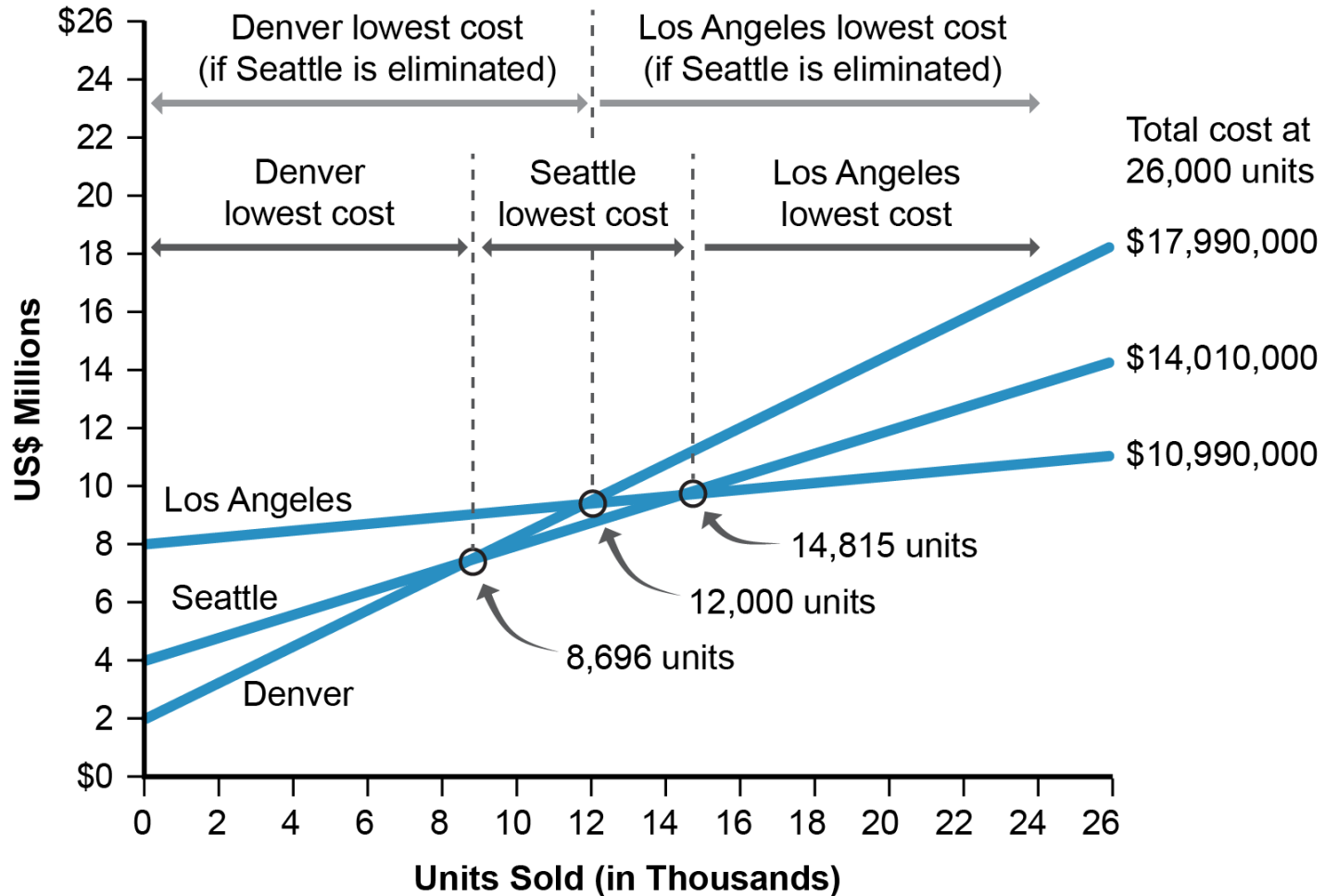
$$\text{Denver-Seattle Crossover Point} = \frac{\$4,000,000 - \$2,000,000}{(\$615/\text{Unit} - \$385/\text{Unit})} = \frac{\$2,000,000}{\$230/\text{Unit}} = 8,696 \text{ Units}$$

$$\text{Seattle-Los Angeles Crossover Point} = \frac{\$8,000,000 - \$4,000,000}{(\$385/\text{Unit} - \$115/\text{Unit})} = \frac{\$4,000,000}{\$270/\text{Unit}} = 14,815 \text{ Units}$$

$$\text{Denver-Los Angeles Crossover Point} = \frac{\$8,000,000 - \$2,000,000}{(\$615/\text{Unit} - \$115/\text{Unit})} = \frac{\$6,000,000}{\$500/\text{Unit}} = 12,000 \text{ Units}$$

Understand Different Network Modeling Approaches

Cost-Volume Analysis Graph



Understand Different Network Modeling Approaches

Other Modeling Methods

Weighted factor rating

Qualitative and quantitative

Priority based
on weight

Weight \times rating

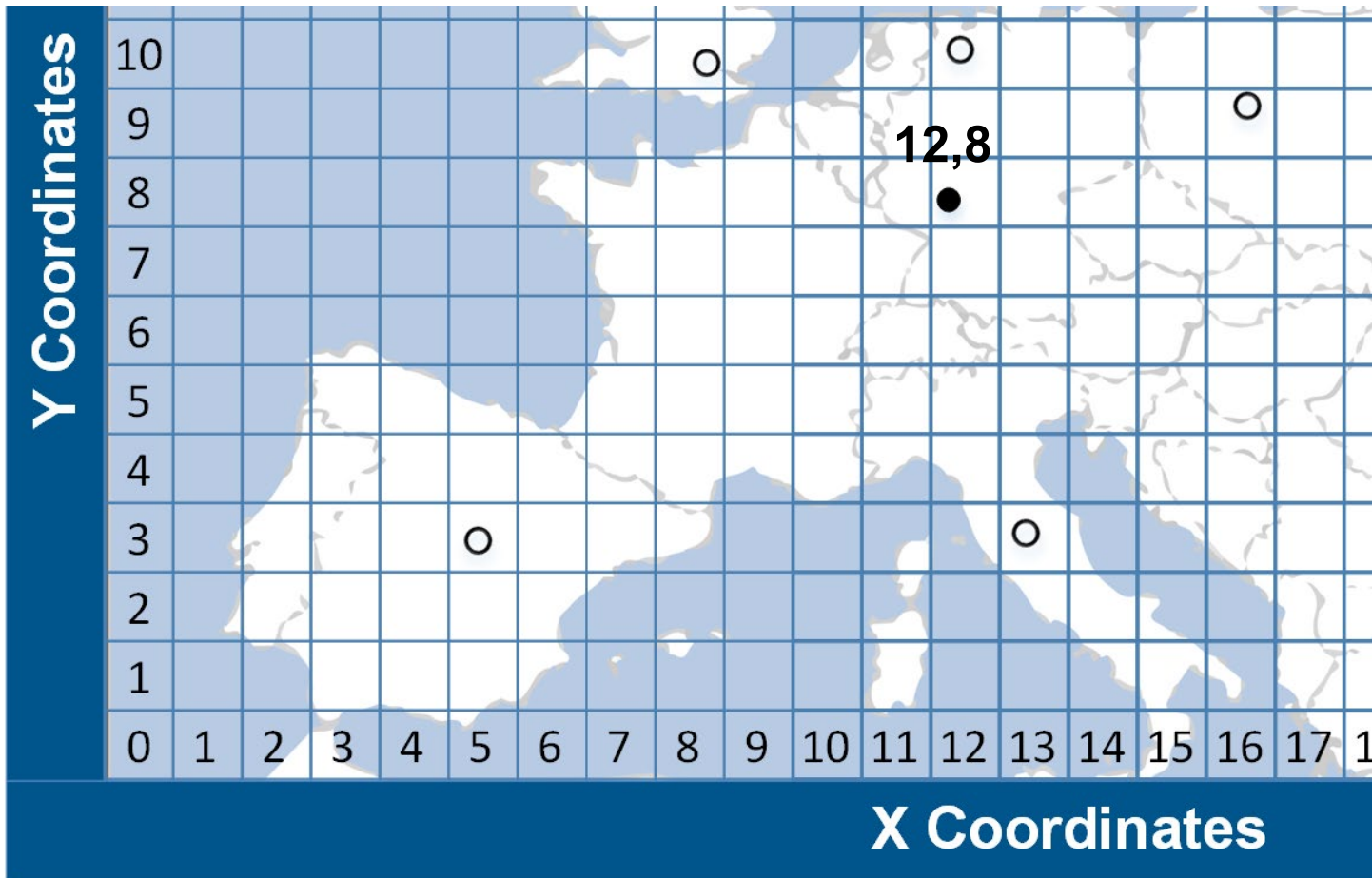
Find finalists and use other tools

Regression analysis

Independent variables predict dependent
variable

Understand Different Network Modeling Approaches

Center-of-Gravity Map



Location	X	Y	Volume
London	8	10	8,000
Warsaw	16	9	9,000
Madrid	5	3	4,000
Hamburg	12	10	11,000
Rome	13	3	6,000
Center of gravity	12	8	38,000

X: Sum of each (x coordinate × volume) ÷ sum of volumes

Y: Repeat for y coordinates

Sum of volumes

Understand Different Network Modeling Approaches

Optimization

- Seeks optimum result.
- Changing any variable yields different answer.
- Significant improvement over heuristics.
- Number of DCs, location, own or lease, make-or-buy, postponement.
- Can use worksheet tools for simple problems.
- ERP systems have network optimization modules.

Understand Different Network Modeling Approaches

Simulation

Sensitivity analysis

One change

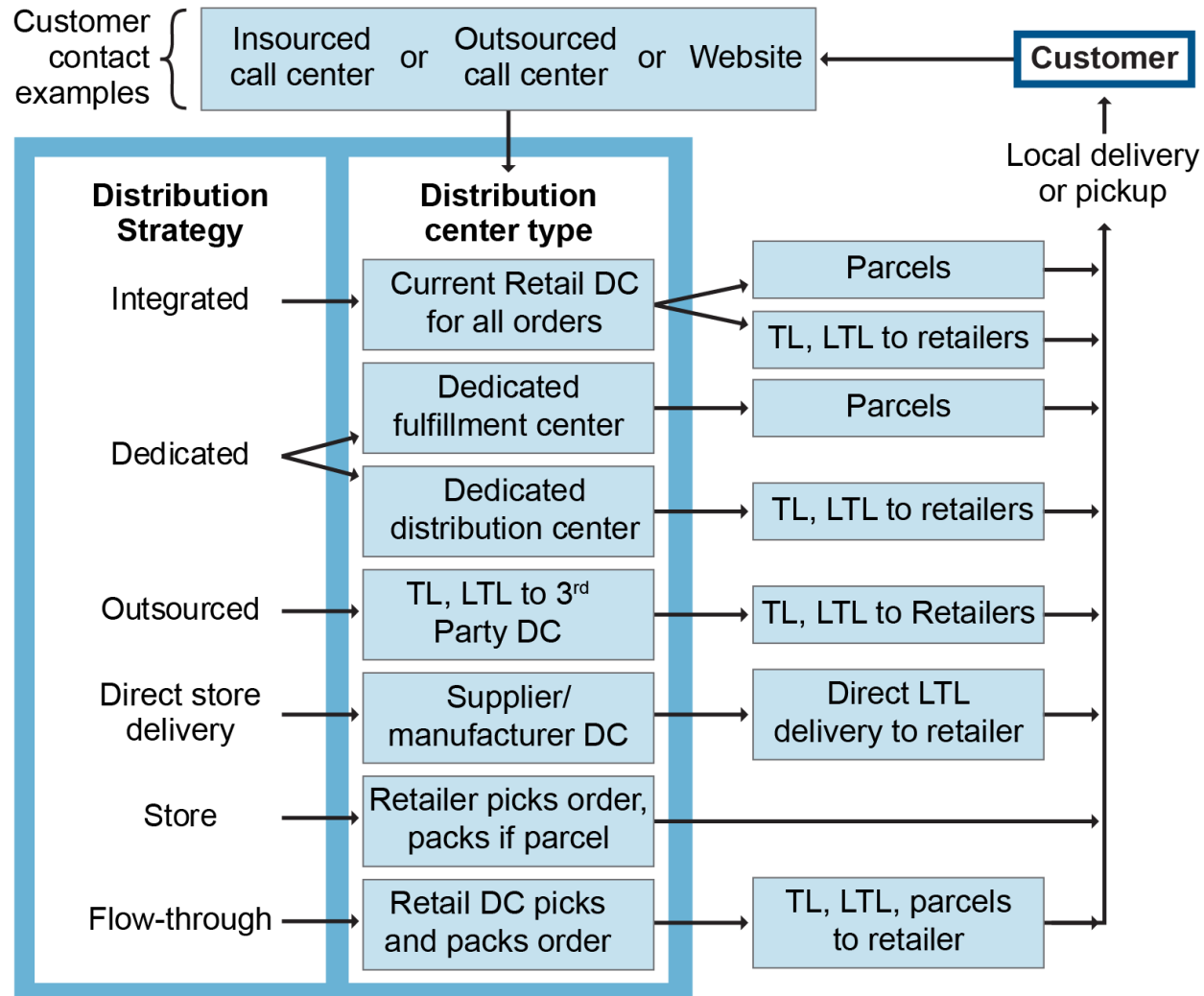
Scenario analysis

“What-if”

Monte Carlo
simulation

Min-max

Order Channels and Distribution Strategies

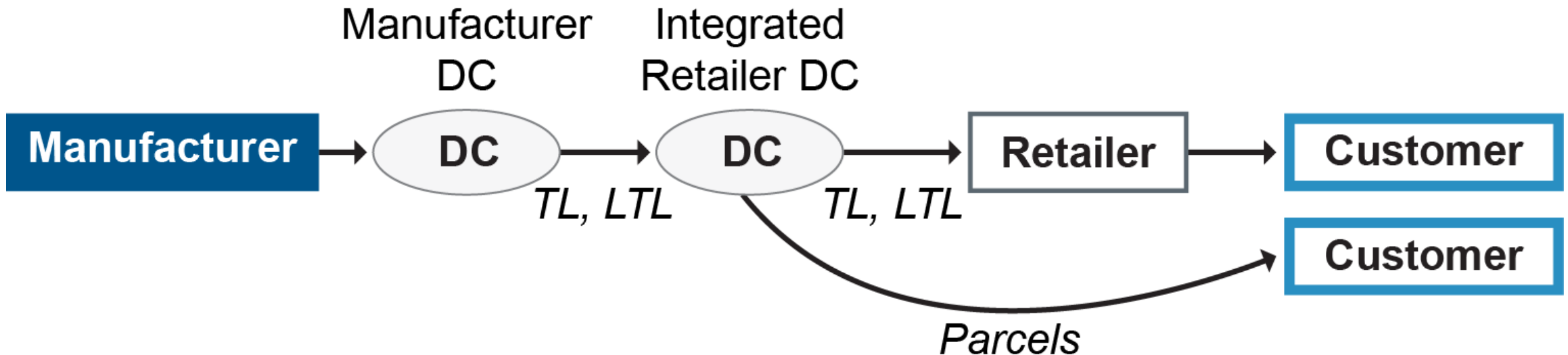


Basic functions of any distribution network:

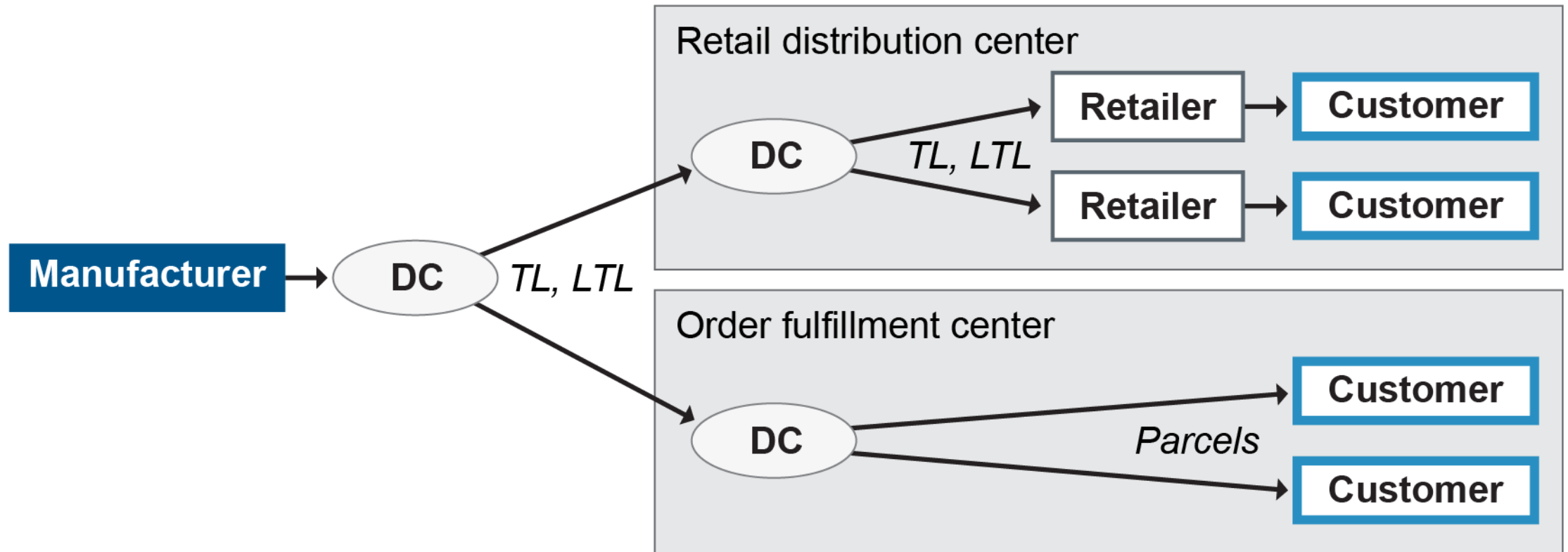
- Sortation
- Accumulation
- Allocation
- Assortment assembly

Integrated Fulfillment

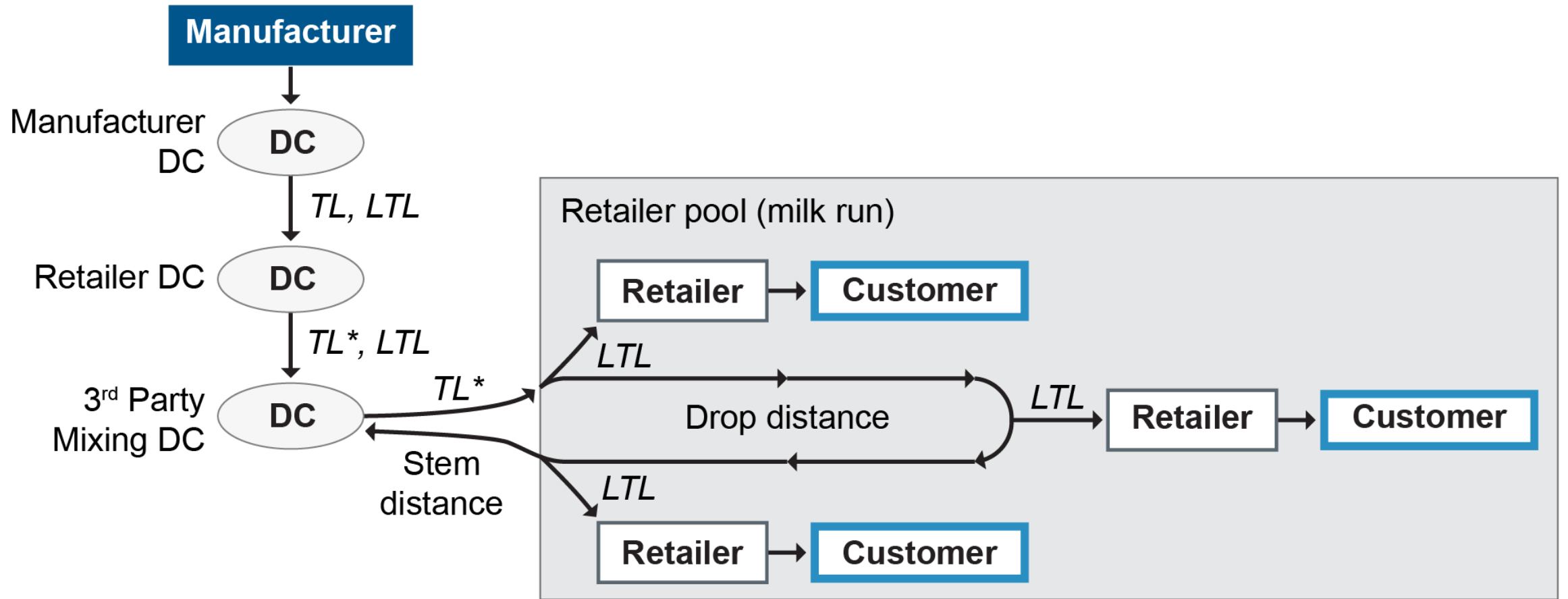
- Leverage existing retail DC to add internet parcel fulfillment without large capital expenses



Dedicated Fulfillment



Outsourced Fulfillment (e.g., Pool Fulfillment)

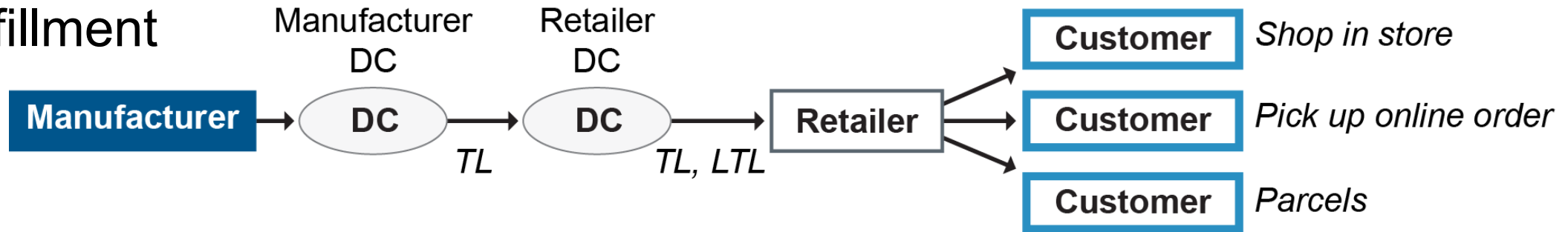


TL* = Full TL shipments of multiple LTL orders

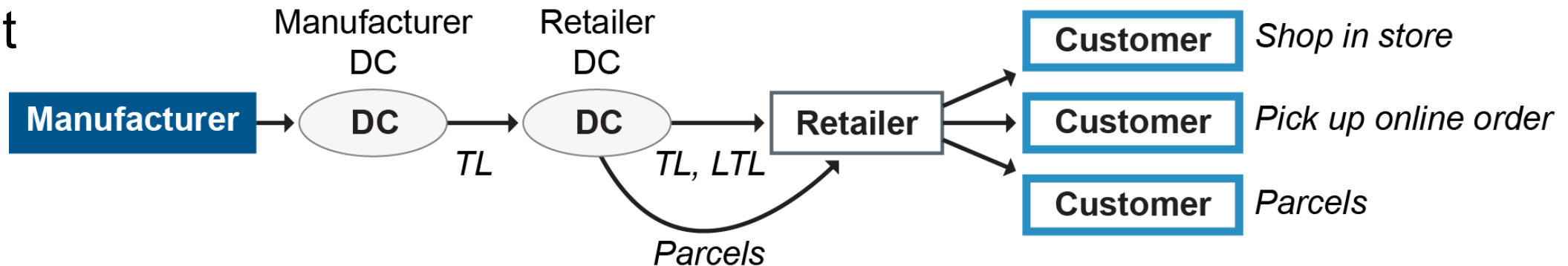
Distribution Plans

Store Fulfillment and Flow-Through Fulfillment

Store Fulfillment



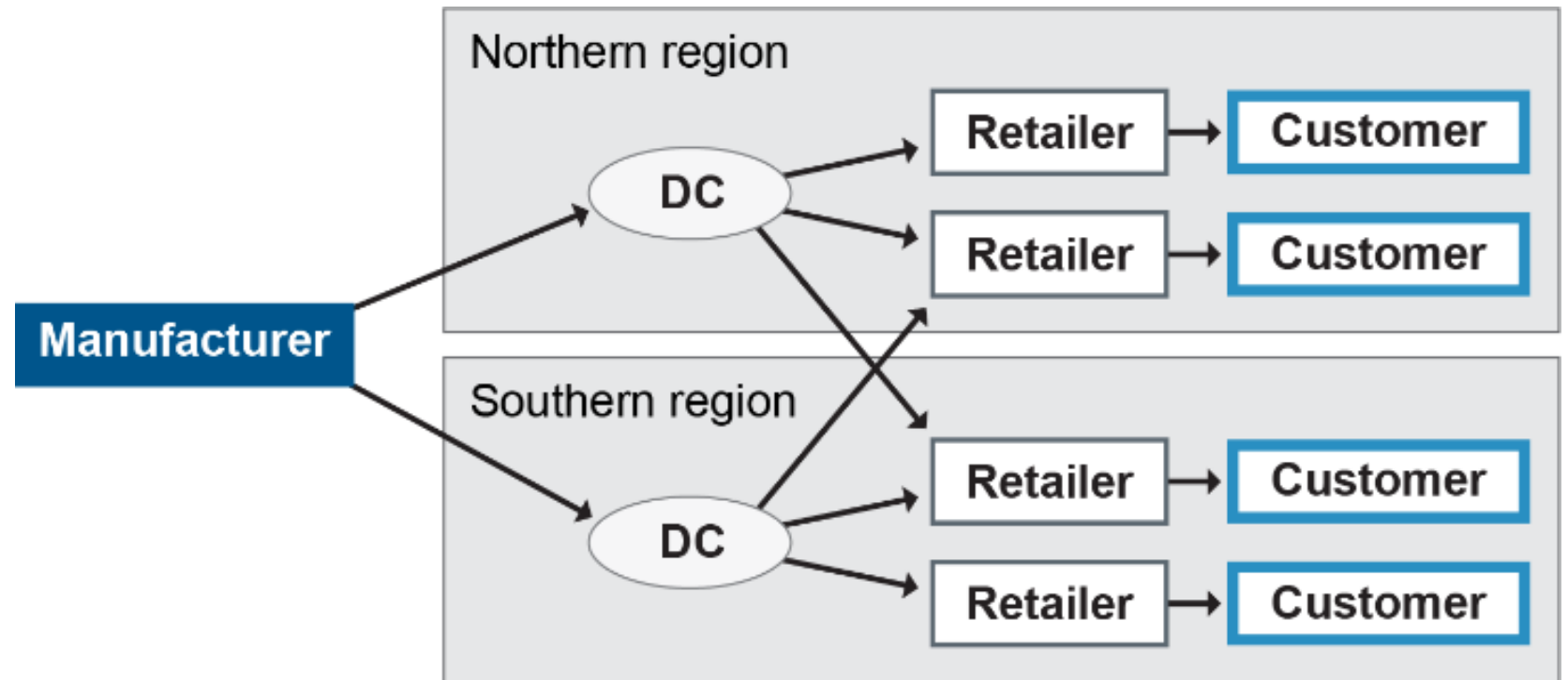
Flow-Through Fulfillment



Distribution Plans

Distribution Networks: Manufacturer to DC to Retailer

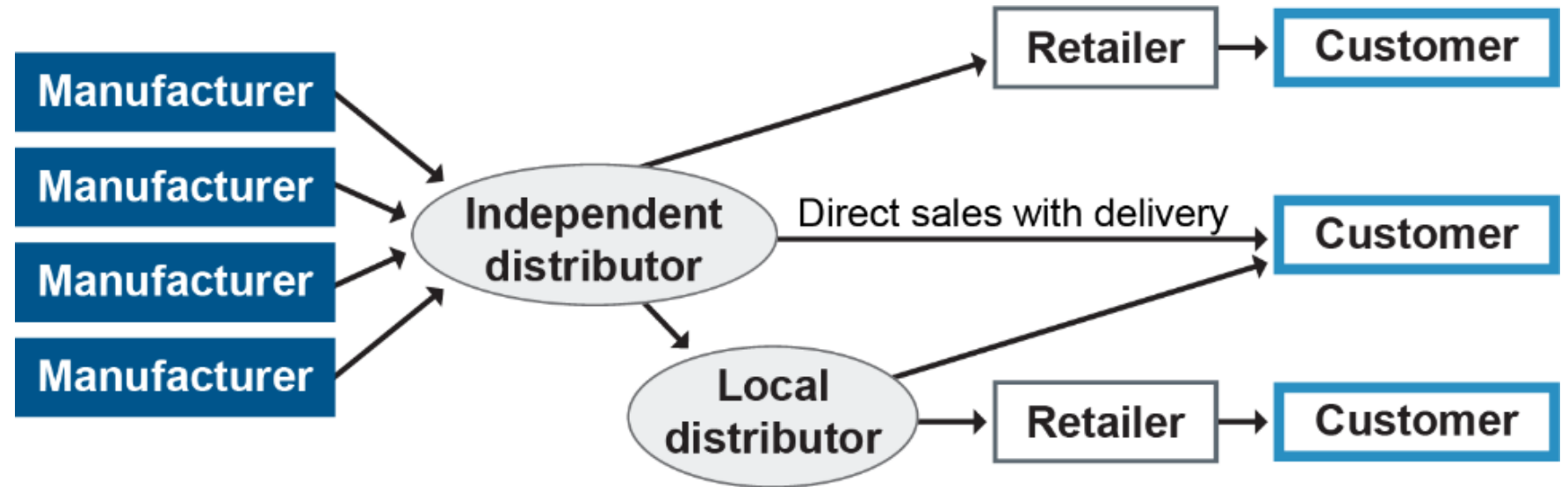
Traditional supply
chain



Distribution Plans

Distribution Networks: Independent Distributor Omni-Channel

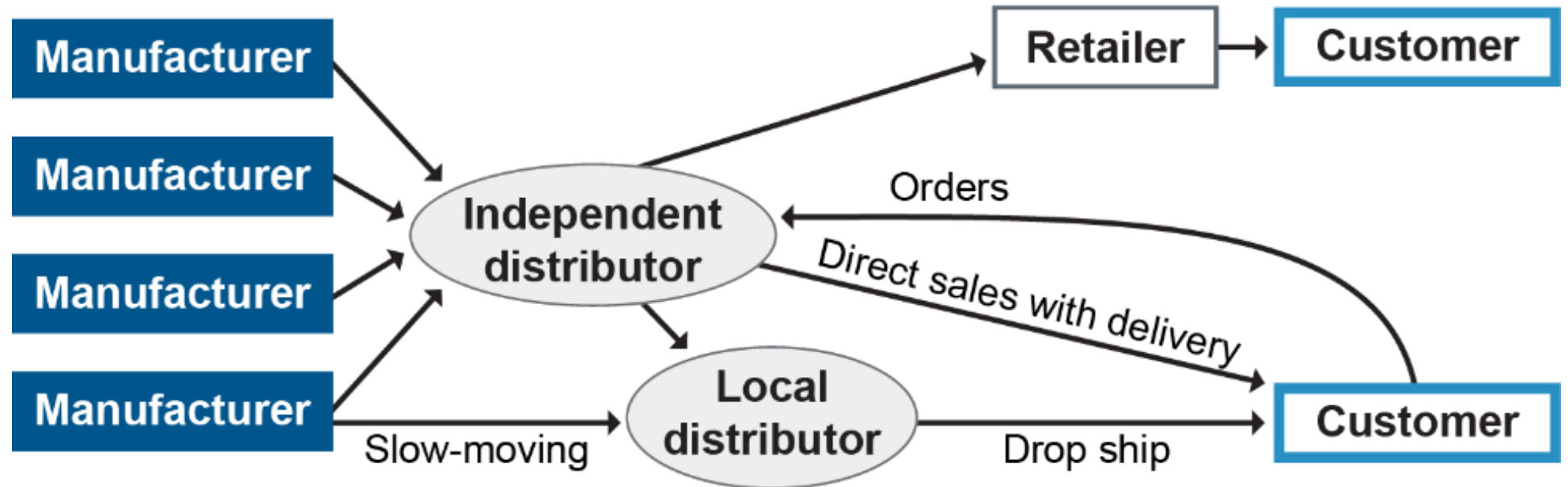
One-stop shop for
retailers, local
distributors,
wholesalers



Distribution Plans

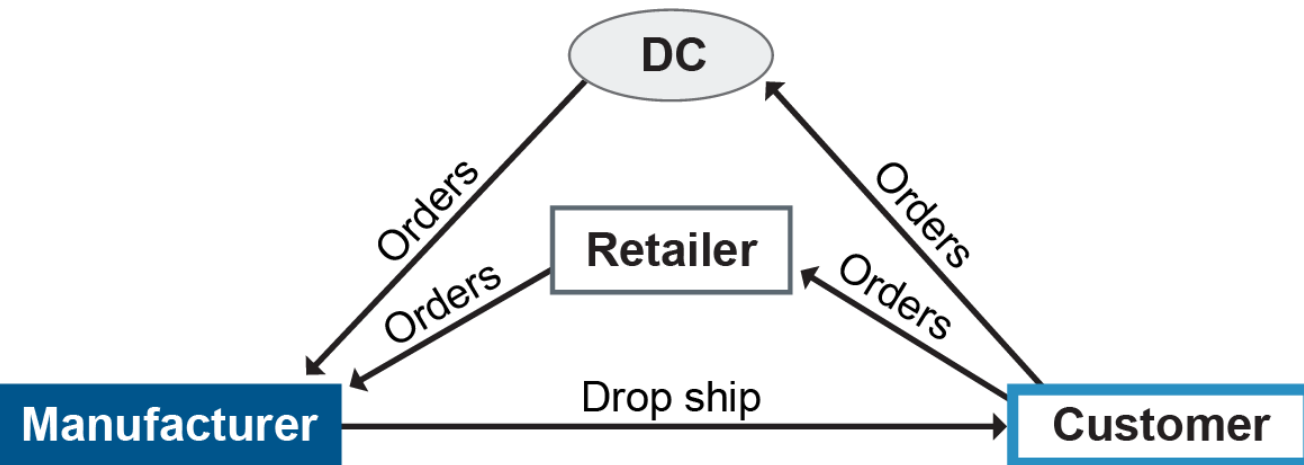
Distribution Networks: Independent Aggregator E- Business Network

- Amazon
- Alibaba

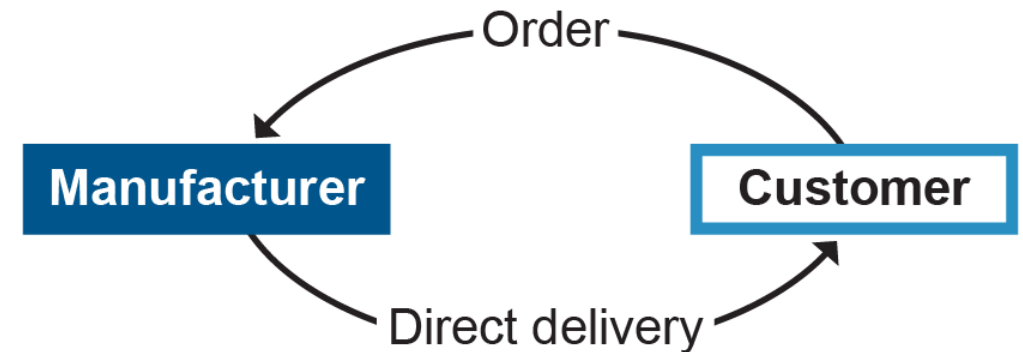


Order Fulfillment Channels (Specific Network Route)

Manufacturer Storage with Drop Ship



Manufacturer Storage with Direct Delivery



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SECTION B: REPLENISHMENT

Section B Learning Objectives

- Pull and push systems
- How DRP monitors inventory levels by location
- Warehouse replenishment systems: reorder point/EOQ, base stock, DRP's TPOP, DDMRP
- SKU replenishment parameters
- Location-specific forecast
- Linkages between DRP, S&OP, and master scheduling

Replenishment Planning

Push versus Pull

Key Attributes	Pull Systems	Push Systems
Replenishment initiation	Decentralized (warehouse)	Centralized (central supply planners)
Inventory planning	At warehouse level	For total system inventory
Customer service	Measured at DC level	Measured systemwide
Reorder point	Order point, min/max, periodic review; at signal—pull item, kanban signal	When projected available balance for future given period is negative or below safety stock level
Systemwide safety stock	High: safety stock carried at each location and level	Lower: consolidated at one location
Organizational implications	Downstream inventory requirements not visible	Central planners responsible; forecasting training; need accurate demand/supply data

Distribution Requirements Planning (DRP)

- Determines need to replenish at distribution centers
- Time-phased order point (TPOP)
 - Logic very similar to MRP
 - Gross requirements from forecast, not explosion
 - Allows for lumpy withdrawals rather than average demand
- Has push and pull features
 - Distribution centers place orders
 - Advance notice for central supply order size suggestions

Improving Performance of Distribution Network

- Quick responses to market changes can be made by relocating products to areas where they are in demand.
- The systems assist management in planning for future requirements in the field.



Robust DRP systems

- Material supply and demand are closely matched.
- Inventory can be located and deployed from specific locations to best meet customer service requirements.

Basic DRP Concepts

- **Coordinates materials flow** through physical distribution system
- **Addresses when, where, and how much** inventory is needed
- **Shapes what resources are needed** to ensure that replenishment inventory can be delivered, handled, and stored per replenishment plans
- **Goal** is efficient, timely service with minimal inventory investment

Replenishment Planning

Warehouse Replenishment Systems

	ROP/EOQ	Base Stock	TPOP	DDMRP
Time	When actual DC inventory reaches reorder point	When scheduled shipment date occurs	Projected on-hand balance offset by lead time	Daily reviews of buffer priorities for ordering (net flow position) and expediting (on hand versus projected)
Amount	Lot size based on EOQ	Actual usage in previous period	Economic shipment quantity based on projected time-phased use	Dynamic based on average daily usage and adjustment factors
Decision point	DC	Lot-for-lot with central location decisions if there is supply demand mismatch	Central location	DC or central location
Complexity	Low	Medium	High	Medium

Replenishment Planning

Time-Phased Order Point (TPOP) Planning

		Period				
	On-Hand	1	2	3	4	5
Forecast requirements		20	20	20	20	20
In-transit						
Projected available balance	32	12	37	17	42	22
Planned order receipts			45		45	
Planned order releases		45		45		

Safety stock: 10 Shipping quantity: 45 Lead time: 1

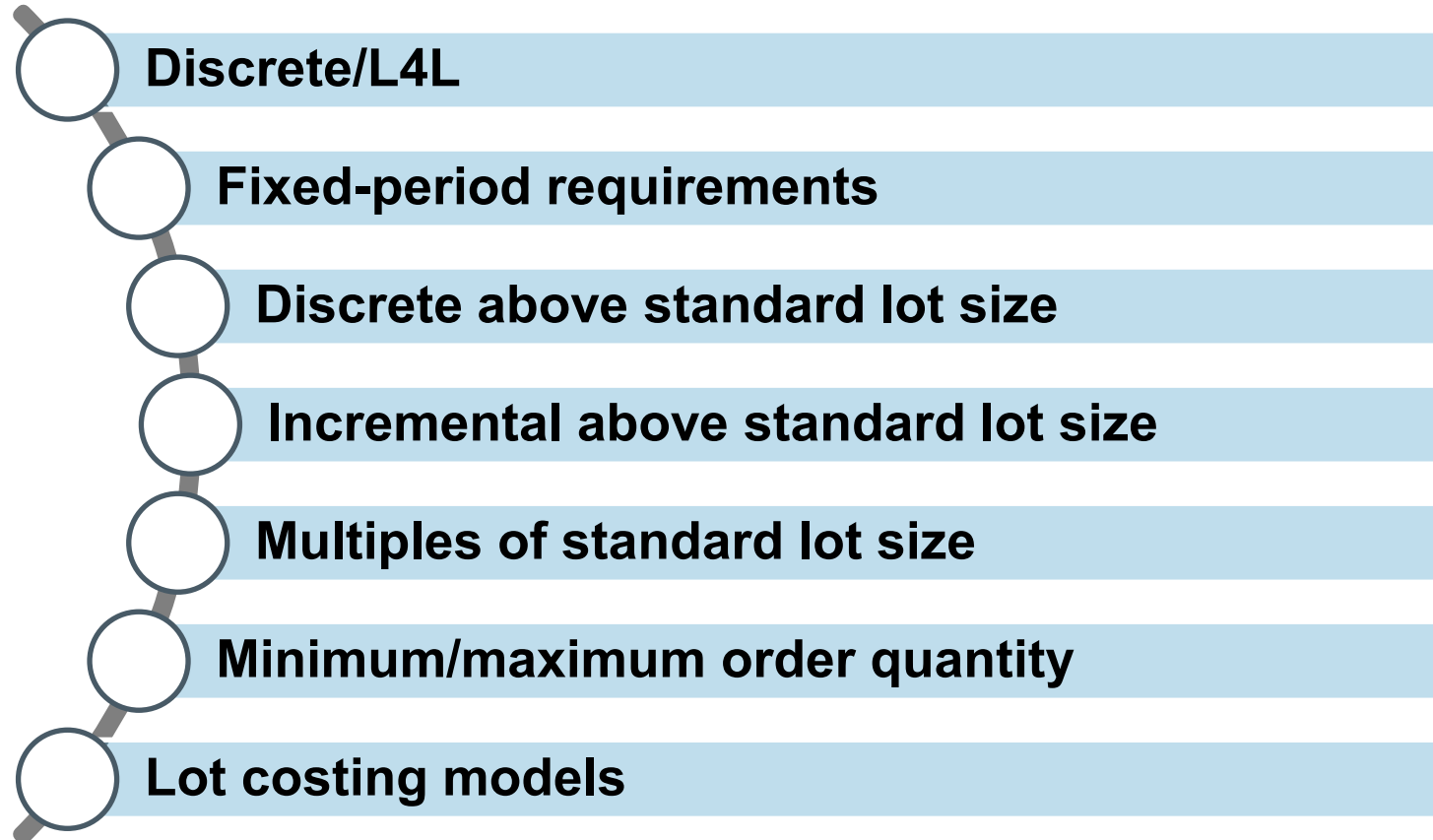
Advantages of TPOP Compared to Q, R

- TPOP provides planned shipment data; Q, R does not.
- TPOP does not assume or require constant consumption.
- TPOP can integrate actual order data, not just planned shipment data.

Demand-Driven MRP (DDMRP) System

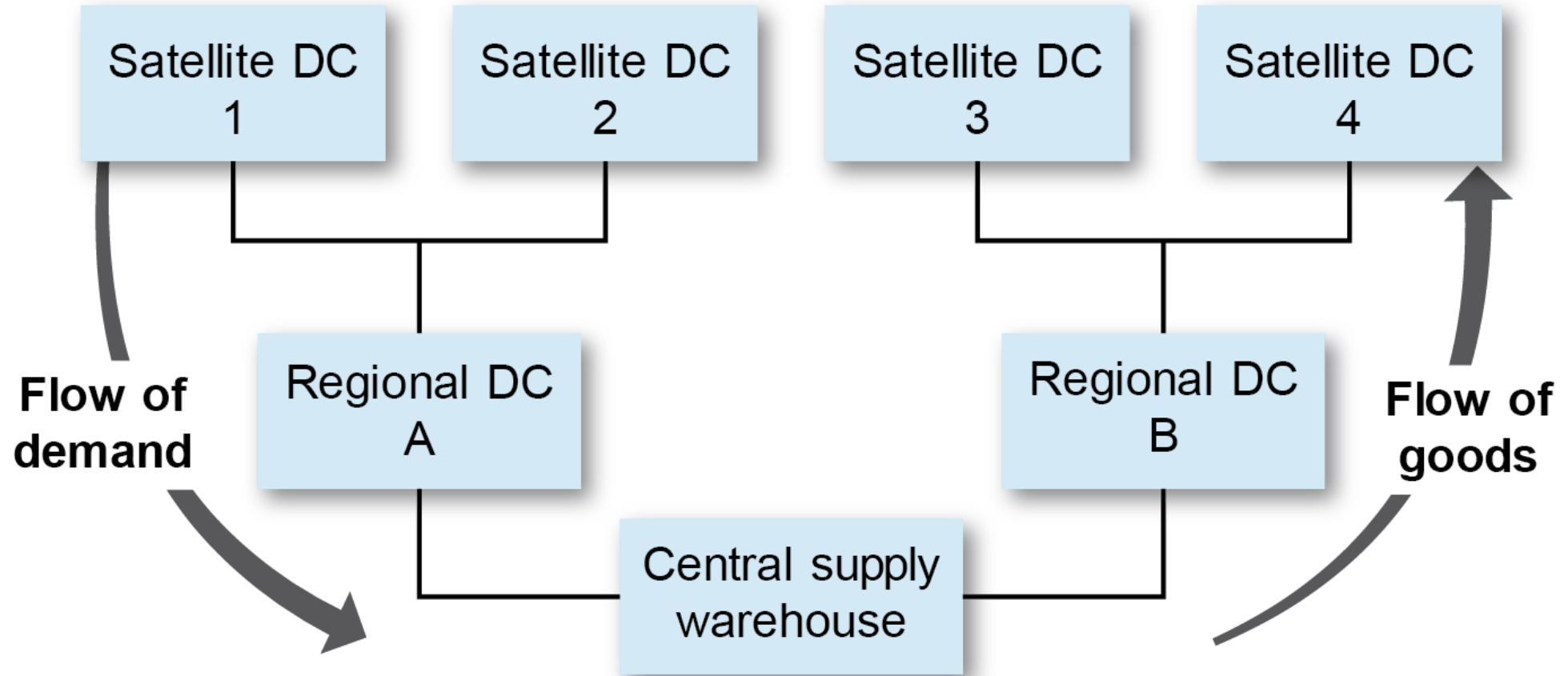
- For dependent and independent demand at any point in supply chain
- Strategic decoupling points or buffers to
 - Reduce lead time, bullwhip effect, and overall inventory
 - Increase customer service KPIs
- Buffer size
 - Item traits: average daily usage, decoupled lead time, order multiples
 - Buffer profiles: part type, lead time, variability
- Buffer zones compare zone status to net flow position (on hand + on order - qualified sales order demand – qualified dependent demand)
 - Green: size and timing of replenishment orders (“order up to” level)
 - Yellow: average amount of replenishment in transit
 - Red: safety stock amount

DRP Order Policies



Distribution Requirements Planning

Bills of Distribution



DC = distribution center

DRP Safety Stock Calculation Options

- Set safety stock using preset number of days of inventory.
- Set safety stock based on usage and lead time.

$$\text{Safety Stock} = (\text{Maximum Daily Usage} \times \text{Maximum Lead Time in Days}) \\ - (\text{Average Daily Usage} \times \text{Average Lead Time in Days})$$

- Estimate safety stock (SS) using square root law.

$$\text{Future SS} = \text{Current SS} \times \sqrt{\frac{\text{Number of DCs in Future}}{\text{Number of DCs in Present}}}$$

Distribution Safety Stock Exercise

1. Safety stock for a product in the region is 500 units. Assuming equal sales from each warehouse, what is the effect on safety stock requirements of increasing the number of satellite DCs to two and locating safety stock in each DC?

$$SS \text{ for DC} = \frac{SS \text{ for 1 DC}}{\sqrt{\text{Number of DCs}}}$$

Where:

SS = Safety stock in each warehouse

DC = Satellite distribution center

$$\text{Safety Stock for Each Satellite DC} = \frac{500}{\sqrt{2}} = \frac{500}{1.414} = 354$$

2. Why not just keep the total safety stock at 500 units by carrying 250 units of safety stock at each location?
3. Under what circumstance would it be appropriate to maintain a total safety stock level of 500 units at a regional DC to cover both satellite DCs?

DRP Inputs, Calculations, and Outputs

- Inputs
 - Planning horizon length and bucket size
 - Item forecast
 - Open customer orders
 - Beginning on-hand quantities
 - Open purchase, interbranch, postponement orders
 - Replenish/finish lead times
 - Safety stock
 - Order policy code
 - Supply sources based on BOD
- Calculations
 - DRP processor populates each planning grid bucket.
 - Bucket resupply is by item's order policy code.
- Outputs
 - Exception reporting
 - Planned orders
 - Action messages
 - Pegged requirements



Distribution Requirements Planning

Distribution Requirements Planning (DRP) Grids

DC A									
Week		1	2	3	4	5	6	7	8
Gross Requirements								300	
Scheduled Receipts									
Projected Available Balance	170	170	170	170	170	170	170	270	270
Net Requirements								200	
Planned Order Receipts								400	
Planned Order Releases							400		

DC B									
Week		1	2	3	4	5	6	7	8
Gross Requirements									500
Scheduled Receipts									
Projected Available Balance	200	200	200	200	200	200	200	200	200
Net Requirements									400
Planned Order Receipts									500
Planned Order Releases							500		

Central Supply									
Week		1	2	3	4	5	6	7	8
Gross Requirements							900		
Scheduled Receipts									
Projected Available Balance	500	500	500	500	500	500	200	200	200
Net Requirements							600		
Planned Order Receipts							600		
Planned Order Releases			600						

Master Schedule Grid							
Week		1	2	3	4	5	6
Gross Requirements				600			
Projected Available Balance	0	0	200	200	200	200	
Master Production Schedule			800				

	Lot Size (units)	Lead Time (weeks)	Safety Stock (units)
DC A	400	1	70
DC B	500	2	100
Central Supply	600	3	200
Master Schedule Grid	800	N/A	N/A

Distribution Requirements Planning

DRP Problem Overview

Warehouse A	Week								
Lot: 100, Lead time: 1, SS: 0		1	2	3	4	5	6	7	8
Gross requirements		80	80	80	70	80	90	90	90
Scheduled receipts									
Projected available balance	90	10	30	50	80	0	10	20	30
Net requirements			70	50	20		90	80	70
Planned order receipts			100	100	100		100	100	100
Planned order releases		100	100	100		100	100	100	

Warehouse B	Week								
Lot: 50, Lead time: 2, SS: 10		1	2	3	4	5	6	7	8
Gross requirements		30	30	30	30	30	35	35	35
Scheduled receipts		50							
Projected available balance	30								
Net requirements									
Planned order receipts									
Planned order releases									

Warehouse C	Week								
Lot: 100, Lead time: 2, SS: 15		1	2	3	4	5	6	7	8
Gross requirements		60	60	70	70	80	90	90	90
Scheduled receipts		100							
Projected available balance	70								
Net requirements									
Planned order receipts									
Planned order releases									

Central Supply	Week								
Lot: 300, Lead time: 2, SS: 50		1	2	3	4	5	6	7	8
Gross requirements									
Scheduled receipts		300							
Projected available balance	250								
Net requirements									
Planned order receipts									
Planned order releases									

Distribution Requirements Planning

DRP Warehouse B Exercise

Warehouse B	Week								
Lot: 50, Lead time: 2, SS: 10		1	2	3	4	5	6	7	8
Gross requirements		30	30	30	30	30	35	35	35
Scheduled receipts		50							
Projected available balance	30	50	20	40	10	30	45	10	25
Net requirements				20		30	15		35
Planned order receipts				50		50	50		50
Planned order releases		50		50	50		50		

Distribution Requirements Planning

DRP Warehouse C Exercise

Warehouse C	Week								
Lot: 100, Lead time: 2, SS: 15		1	2	3	4	5	6	7	8
Gross requirements		60	60	70	70	80	90	90	90
Scheduled receipts		100							
Projected available balance	70	110	50	80	110	30	40	50	60
Net requirements				35	5		75	65	55
Planned order receipts				100	100		100	100	100
Planned order releases		100	100		100	100	100		

Distribution Requirements Planning

DRP Central Supply Gross Requirements Exercise

Warehouse A	Week								
Lot: 100, Lead time: 1, SS: 0		1	2	3	4	5	6	7	8
Gross requirements		80	80	80	70	80	90	90	90
Scheduled receipts									
Projected available balance	90	10	30	50	80	0	10	20	30
Net requirements			70	50	20		90	80	70
Planned order receipts			100	100	100		100	100	100
Planned order releases		100	100	100		100	100	100	

Warehouse B	Week								
Lot: 50, Lead time: 2, SS: 10		1	2	3	4	5	6	7	8
Gross requirements		30	30	30	30	30	35	35	35
Scheduled receipts		50							
Projected available balance	30	50	20	40	10	30	45	10	25
Net requirements				20		30	15		35
Planned order receipts				50		50	50		50
Planned order releases		50		50	50		50		

Warehouse C	Week								
Lot: 100, Lead time: 2, SS: 15		1	2	3	4	5	6	7	8
Gross requirements		60	60	70	70	80	90	90	90
Scheduled receipts		100							
Projected available balance	70	110	50	80	110	30	40	50	60
Net requirements				35	5		75	65	55
Planned order receipts				100	100		100	100	100
Planned order releases		100	100		100	100	100		

Central Supply	Week								
Lot: 300, Lead time: 2, SS: 50		1	2	3	4	5	6	7	8
Gross requirements		250	200	150	150	200	250	100	0
Scheduled receipts		300							
Projected available balance	250								
Net requirements									
Planned order receipts									
Planned order releases									

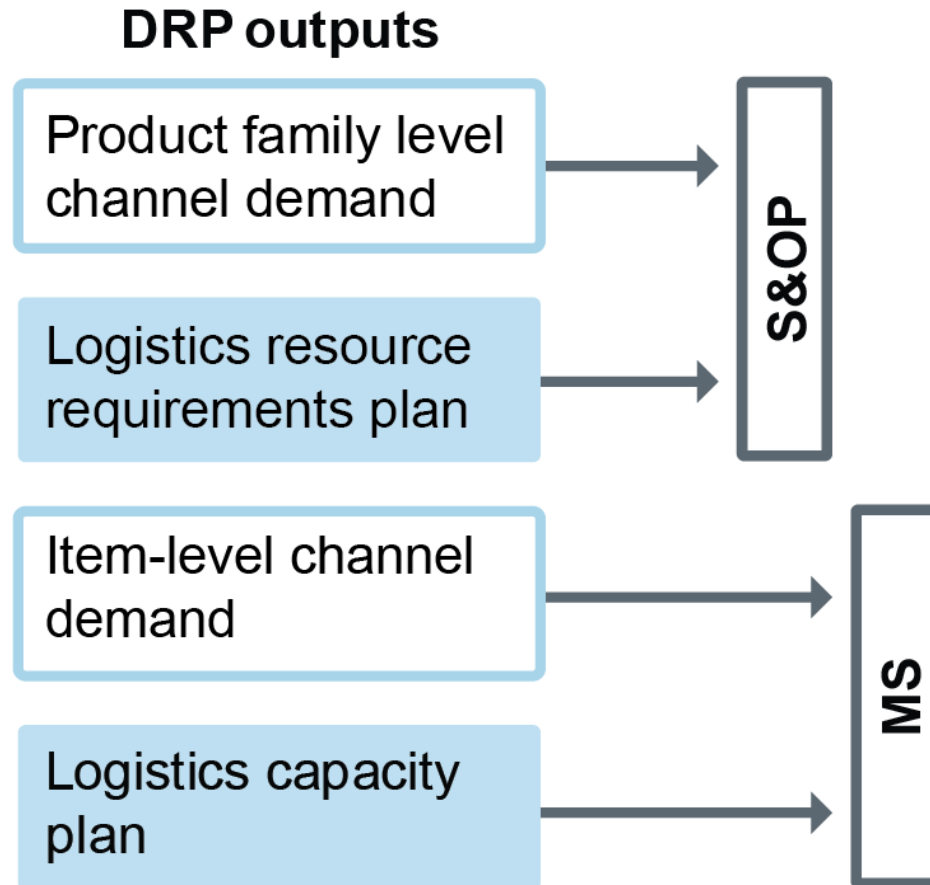
Distribution Requirements Planning

DRP Central Supply Exercise

Central Supply	Week								
Lot: 300, Lead time: 2, SS: 50		1	2	3	4	5	6	7	8
Gross requirements		250	200	150	150	200	250	100	0
Scheduled receipts		300							
Projected available balance	250	300	100	250	100	200	250	150	150
Net requirements				100		150	100		
Planned order receipts				300		300	300		
Planned order releases		300		300	300				

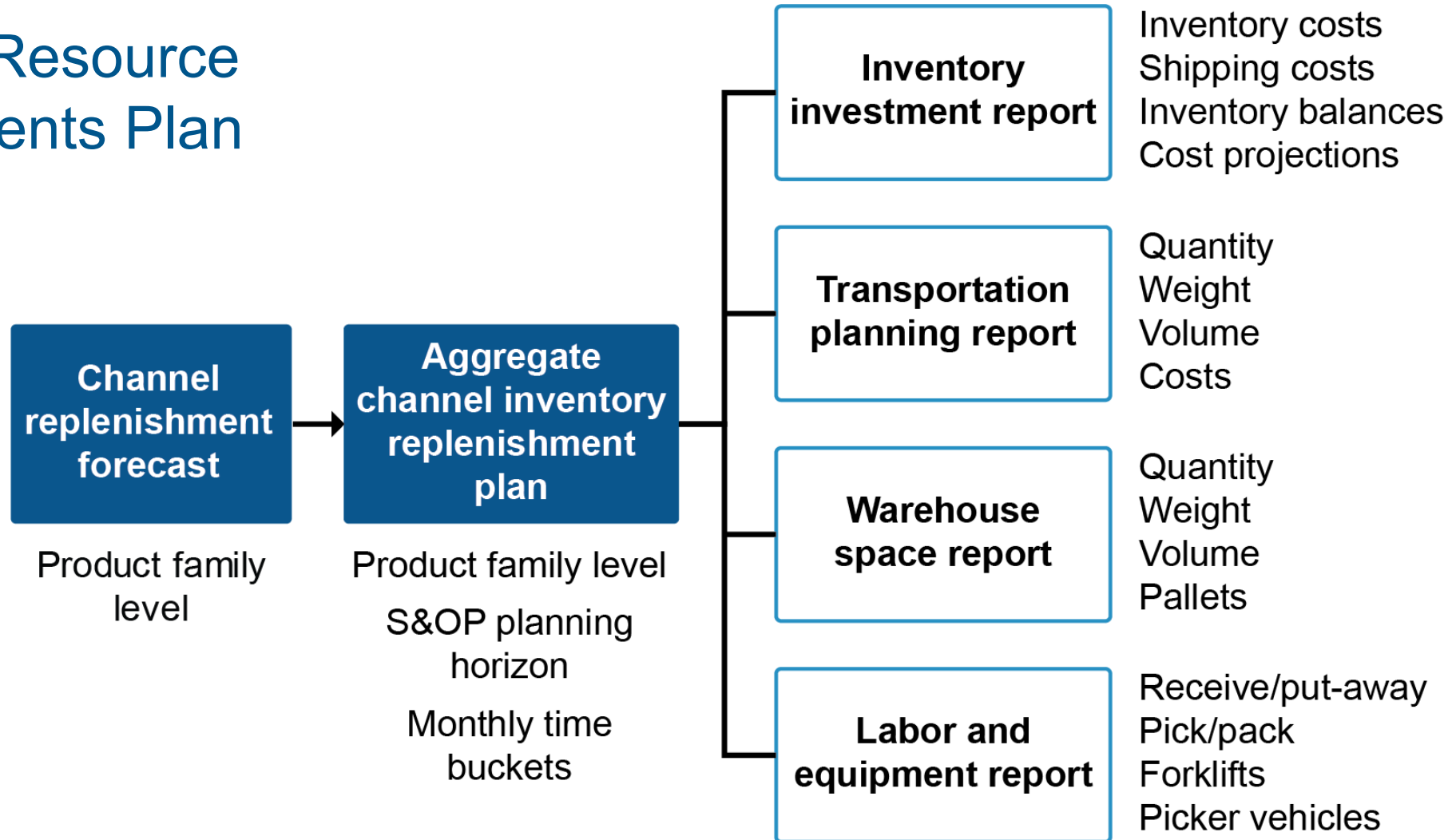
Distribution Requirements Planning

Linking DRP, S&OP, and Master Scheduling



Distribution Requirements Planning

Logistics Resource Requirements Plan



CPIM CERTIFIED IN PLANNING AND INVENTORY MANAGEMENT

SECTION C: ORDER MANAGEMENT, TRACE/TRACK, AND KPIS

Section C Learning Objectives

- Order management, including monitoring availability and lead time
- Order cycle stages
- Expediting
- Inventory tracking technology
- Methods of identifying and tracing inventory
- Product recall guidelines
- Distribution KPIs
- Data collection methods for gathering feedback

Order Cycle Stages (B2B)

Stage 1: Order Transmittal

1. Customer requests information and price is quoted.
2. Customer places order.

Stage 2: Order Processing

3. Order is received and entered into system.
4. Reserve inventory and identify delivery date.
5. Consolidate orders for freight and warehouse picking.
6. Plan and build loads.
7. Route shipments.
8. Use routing guide to select carriers and rates.

Stage 3: Order Picking and Packing

9. Pick reserved product(s) at depot/distribution centers.
10. Load vehicle and create shipping documents.

Stage 4: Order Delivery

11. Receive and verify product order at customer site.
12. Install product if required.
13. Invoice and receive payment.

Exceptions and Expediting

Exceptions

- Problem during any portion of the delivery process
- Transporter not liable for external issues; is liable for negligence

Open Order Monitoring

- Pre-expediting process to ensure timely delivery

Expediting supply or transportation

- Taking extraordinary action because of increase in relative priority

Traceability Requirements

Inventory ID and documentation

- Products, cartons, pallets, etc.
- Class, batch/lot, instance

Transportation documentation

- Certificate of origin/manufacture
- Shipper's export declaration

Adherence to traceability standards

- Examples: ISO and GS1 standards

Adherence to product recall guidelines

- Specific to jurisdiction

Providing Order Visibility

Tracking in-transit inventory

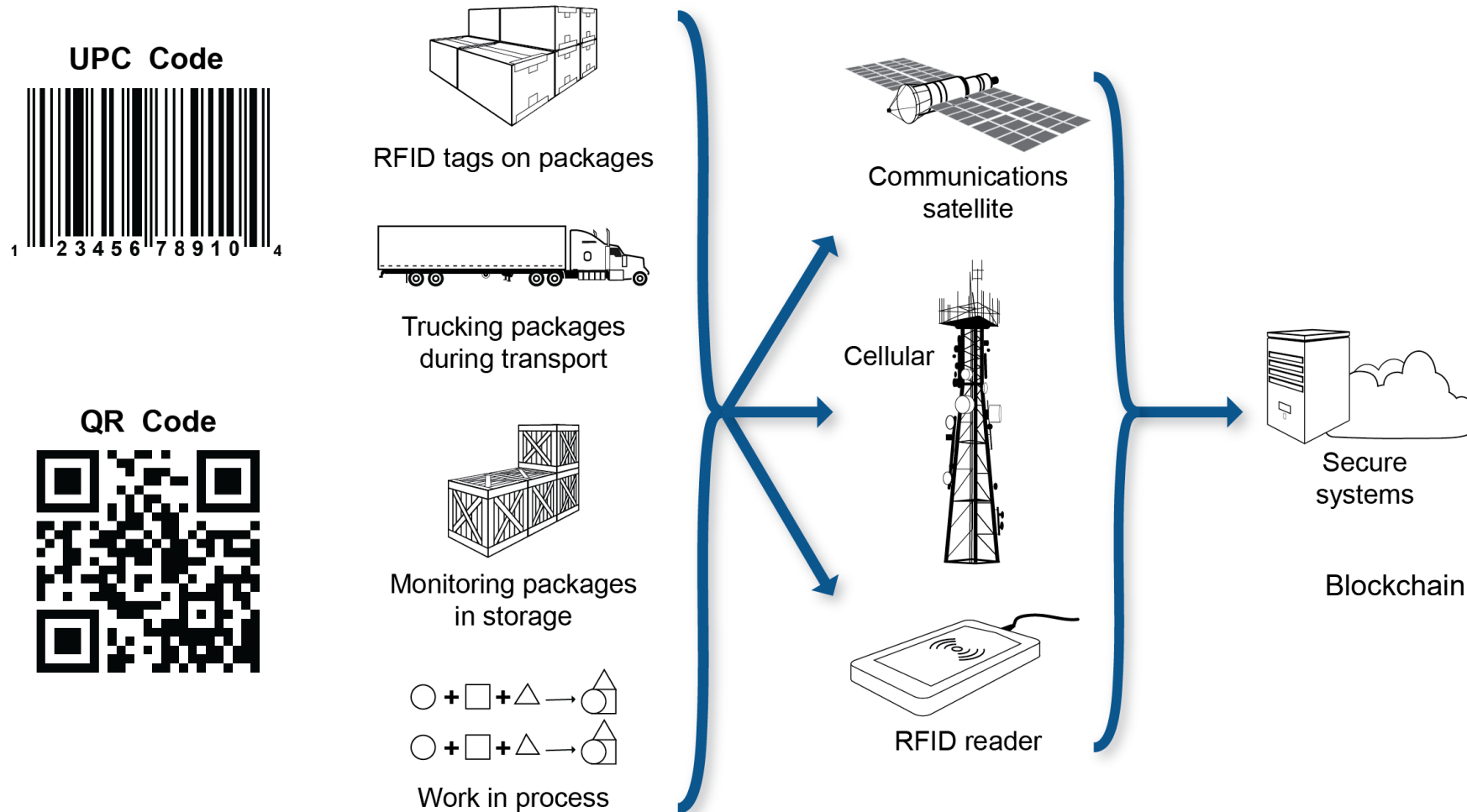
- Track by purchase orders, SKUs, etc.
- Customize to need by specific role
- Access by buyers and suppliers via batch process or blockchain

Advanced shipping notice (ASN)

- Allows buyer time to prepare for receipt and plan deployment of contents
- Reduces uncertainty in order replenishments

Inventory Traceability and Tracking

Inventory Tracking: Barcodes and RFID



Performance Indicators

- Service
- Fast flow response
- Reduction of operating variance
- Minimum inventories
- Transportation reduction
- Quality management
- Product life cycle support



Distribution System Performance Measures

Customer service

- % of orders satisfied from stock
- % of units required filled from stock
- % of units required delivered on time
- % of units delivered by original customer commit date
- % of item stockouts
- % of stock cycles without shortages
- % of months without stockout

Distribution efficiency

- % throughput
- % order filling
- % shipping accuracy
- % inventory record accuracy
- % storage utilization

Inventory management

- Inventory turns
- Cash-to-cash cycle

Data Collection Methods



Email and
contact forms



Feedback
surveys



Interviews/
focus groups



Social media

Improvements in Distribution Planning Process



- Fill rates
- Average length of time required to satisfy backorders
- Percentage of order replenishment cycles in which one or more units are backordered