Operations Research in Supply Chain Optimization

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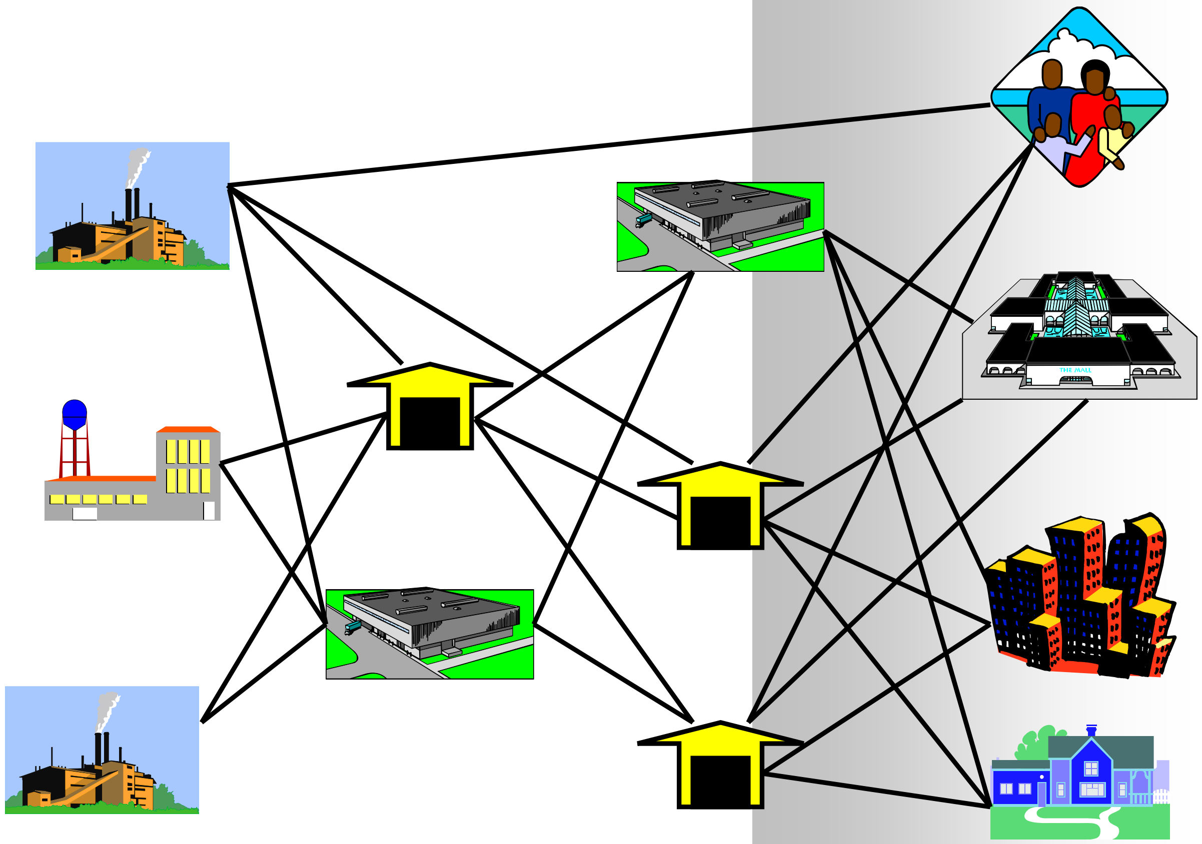
The supply chain



Suppliers → factories → warehouses → customers

Goal of supply chain management

To efficiently integrate suppliers, producers, warehouses to produce and distribute

- the right quantity
- at the right time
- in the right place

Operations Research

while maximizing the total profit and guaranteeing an appropriate service level

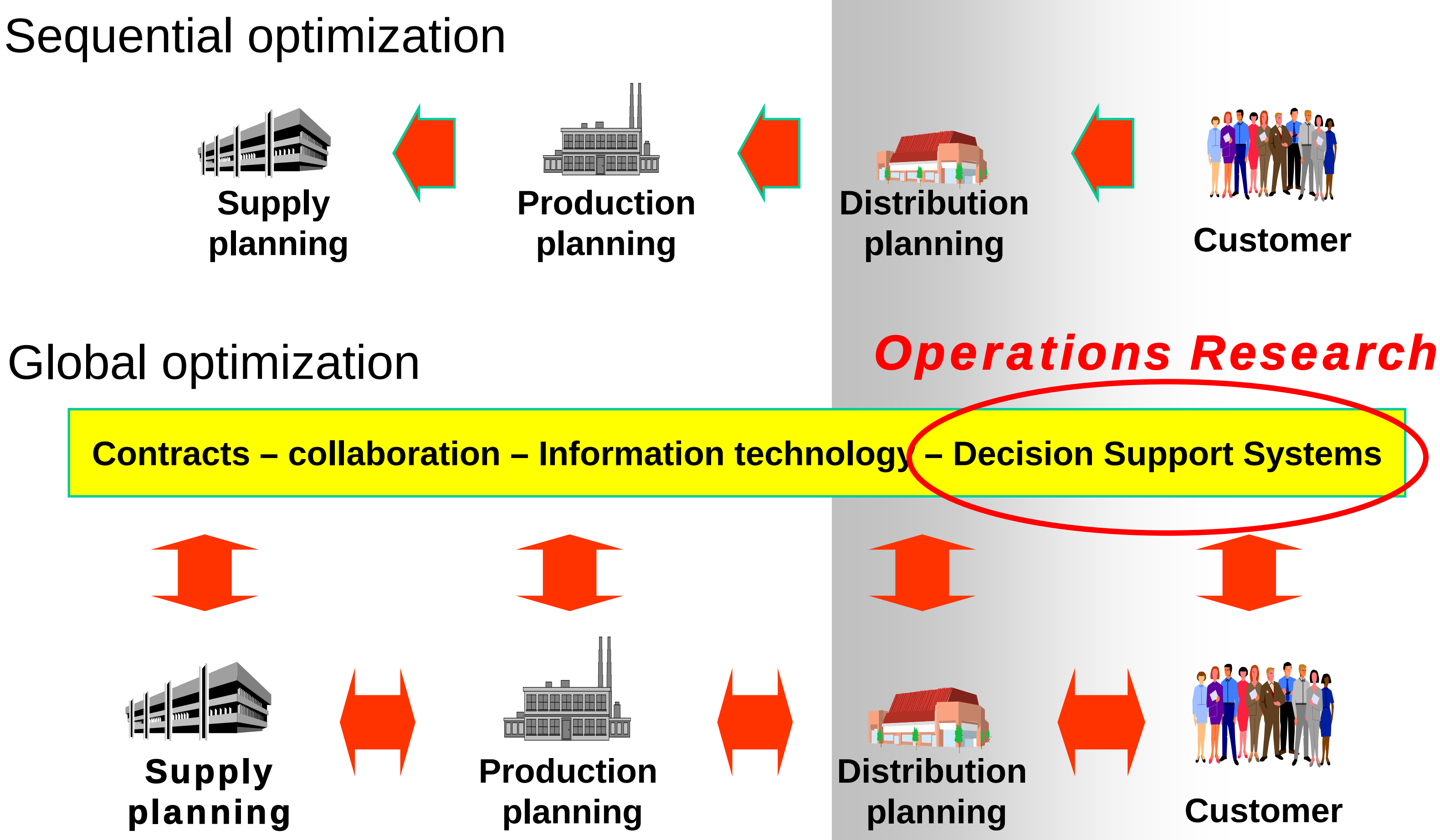
Goal of supply chain management

- All strategies, techniques, approaches in supply chain management are focused on:

Operations Research

  - Global optimization
  - Uncertainty management

Global optimization



Global optimization

- Search process of the best strategy for the entire supply chain to:

Operations Research

maximize overall value created

  - Supply chain value: difference between what the final product is worth to the customer and the effort the supply chain expends in filling the customer's request

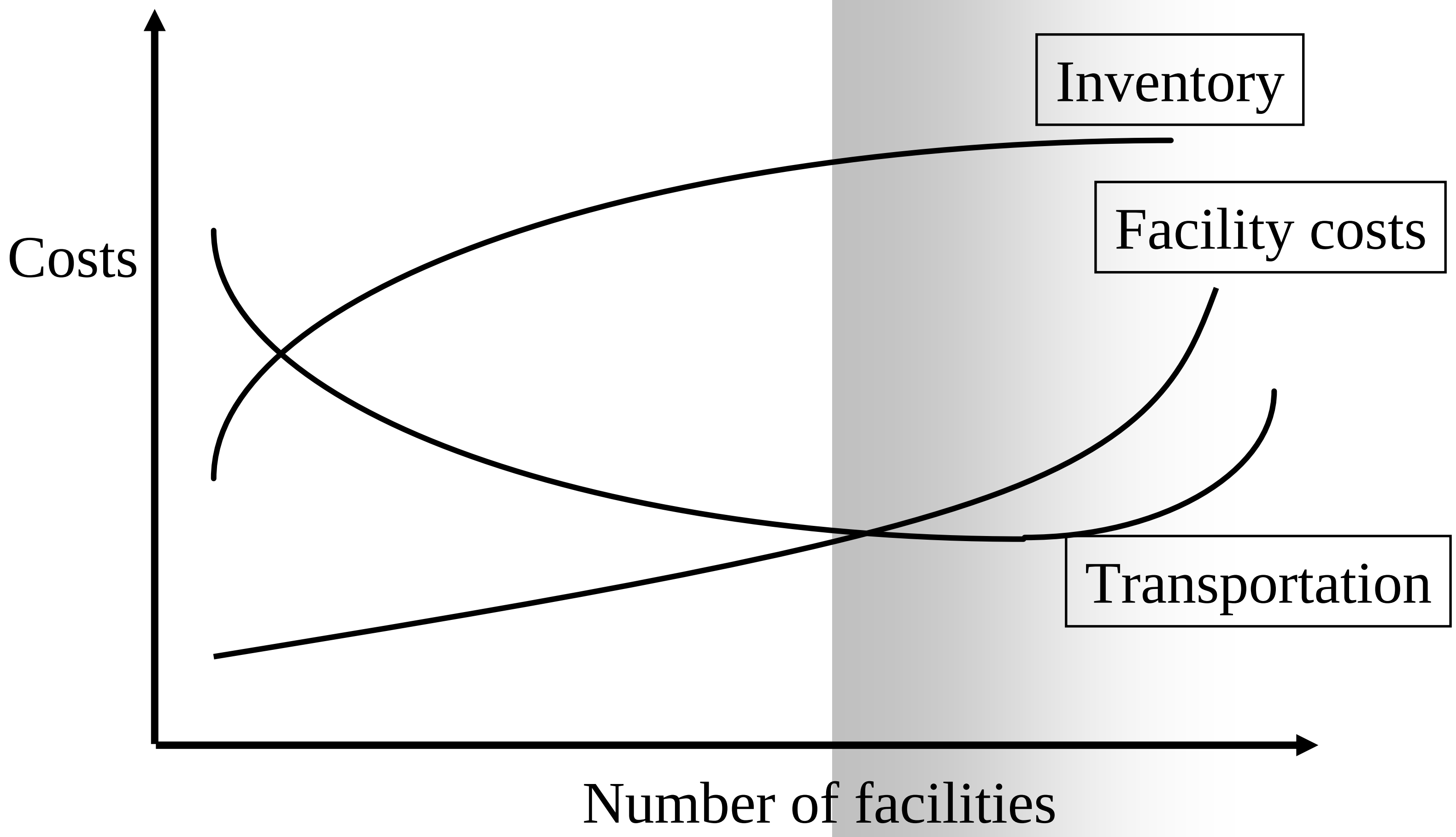
Why is it difficult?

- The supply chain is complex
- The different actors have different goals
- The supply chain evolves upon time
- The system varies (changes, demand, costs)

Operations Research

A need of sophisticated tools, models, algorithms

An example of complexity



Conflicting objectives

- Lot Size – Inventory
- Inventory – Transportation
- Lead Time – Transportation
- Product Variety – Inventory
- Cost – Customer Service

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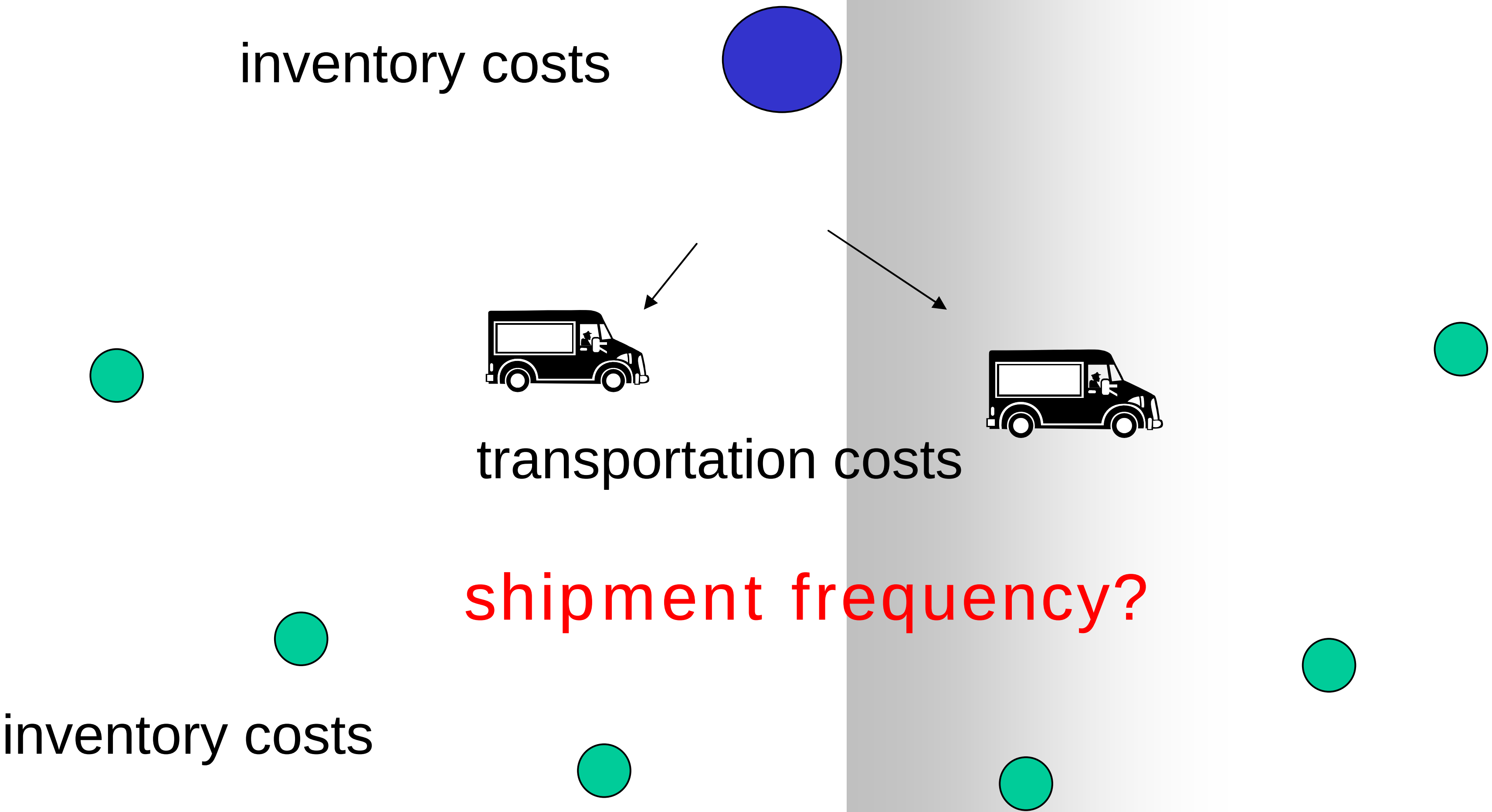
A distribution network



Conflicting objectives

Main reason for infrequent (full load) transportation:
minimize transportation costs

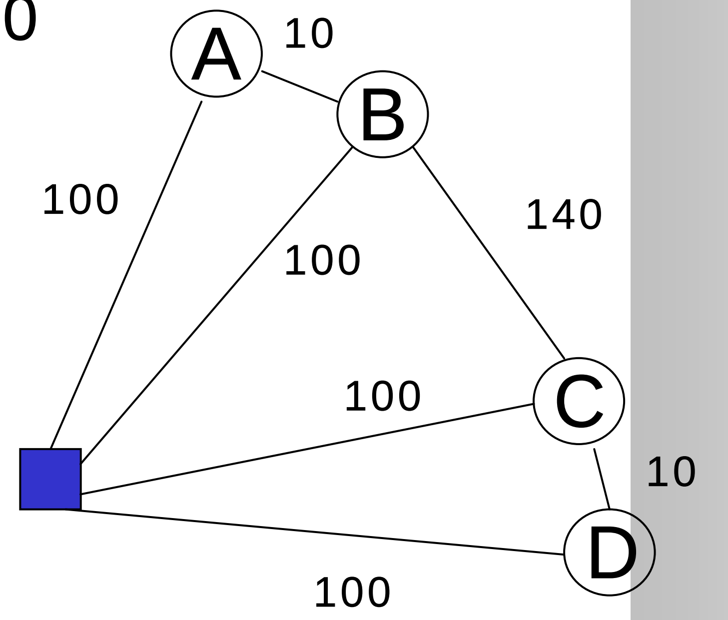
Main reason for frequent transportation:
minimize inventory costs

Problem: Minimize transportation or inventory costs?

Minimize the sum of inventory and transportation costs

The value of integration

1 vehicle
capacity 100

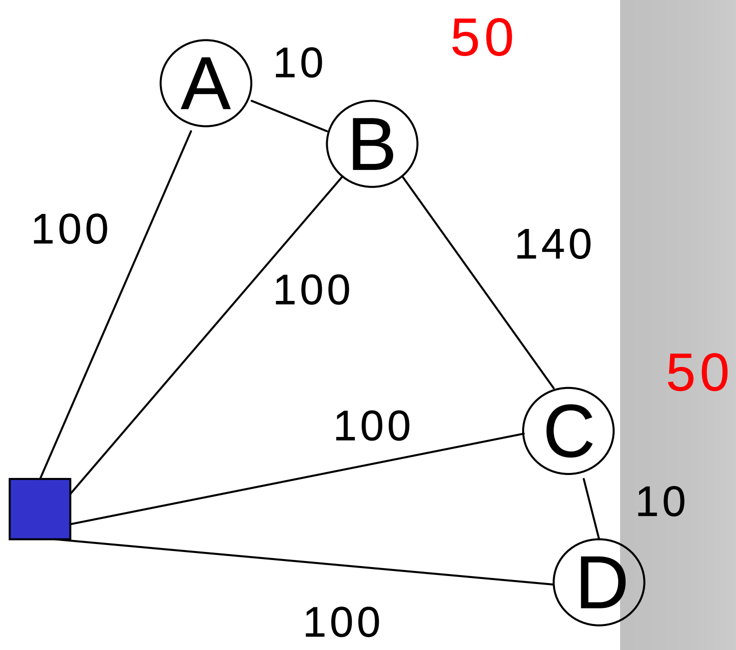


frequency of service
is every 2 days

customers decide when and how much
supplier decides routes

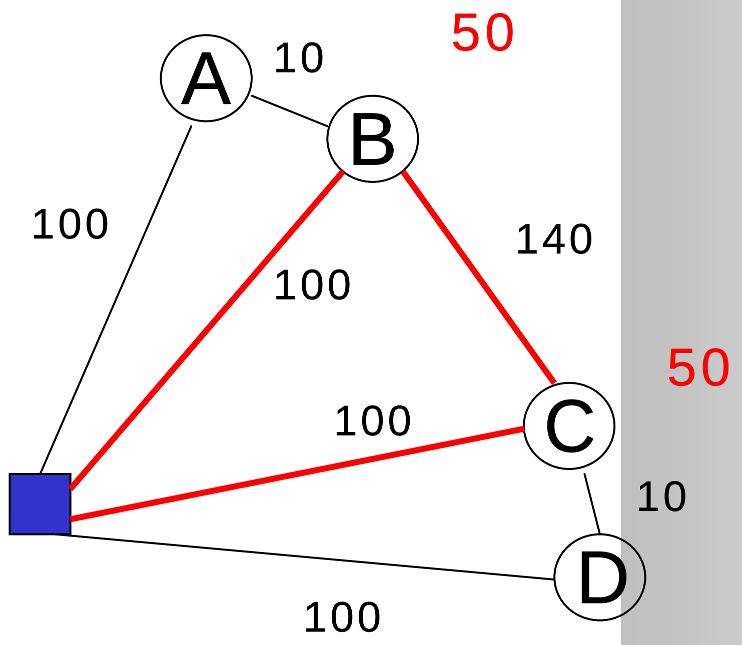
The value of integration

Day 1



The value of integration

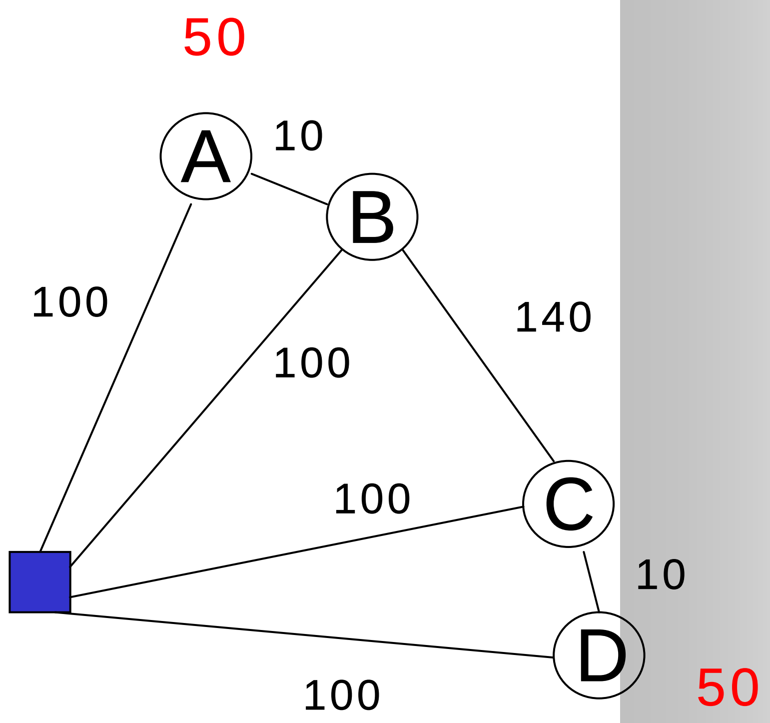
Day 1



Cost=340

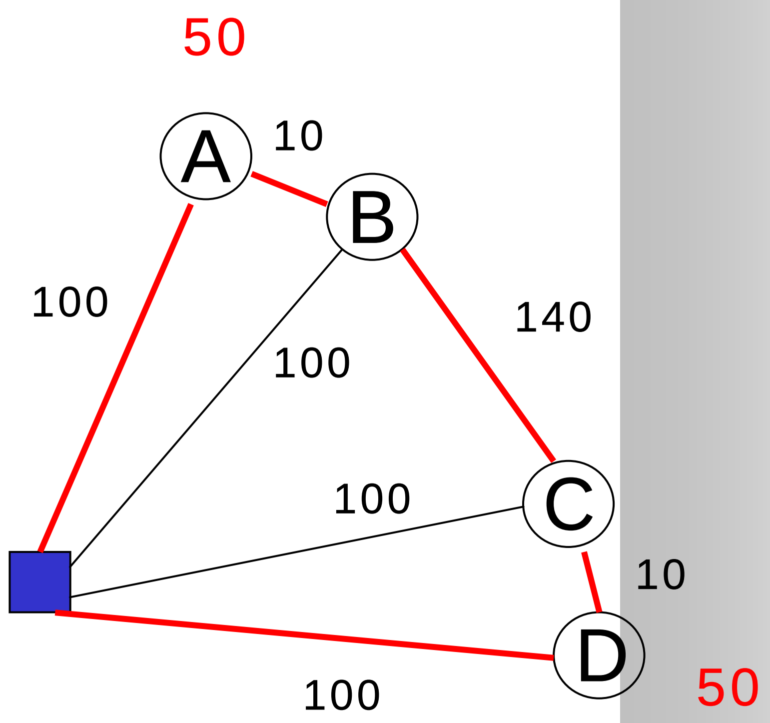
The value of integration

Day 2



The value of integration

Day 2

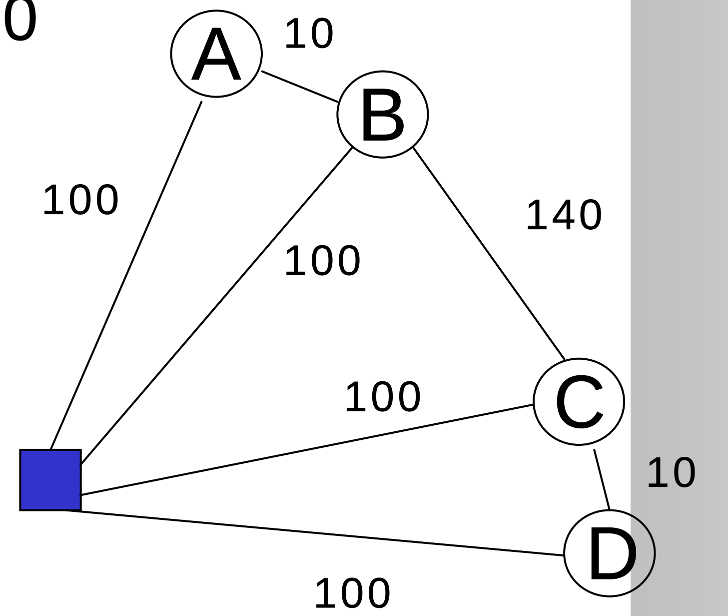


Cost=360

Cost over two days=700

The value of integration

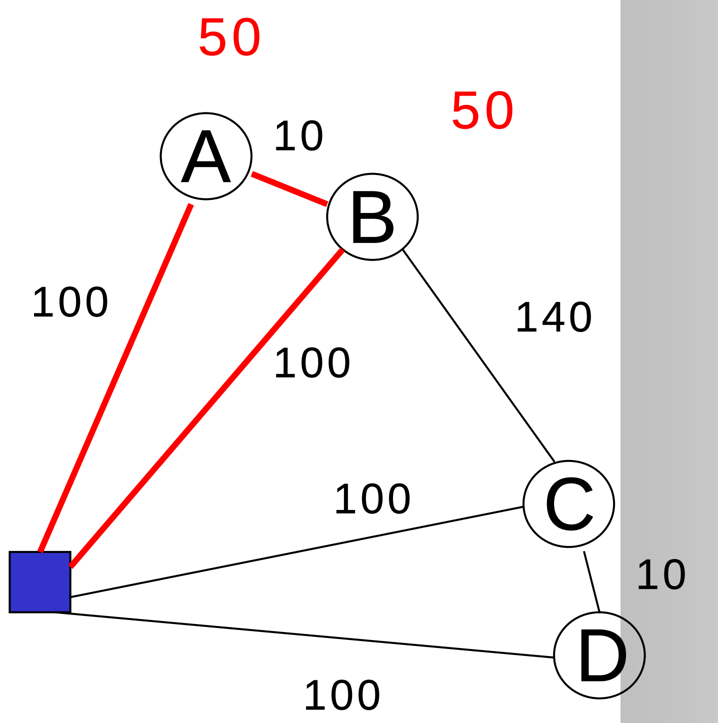
1 vehicle
capacity 100



supplier decides when, how much and routes

The value of integration

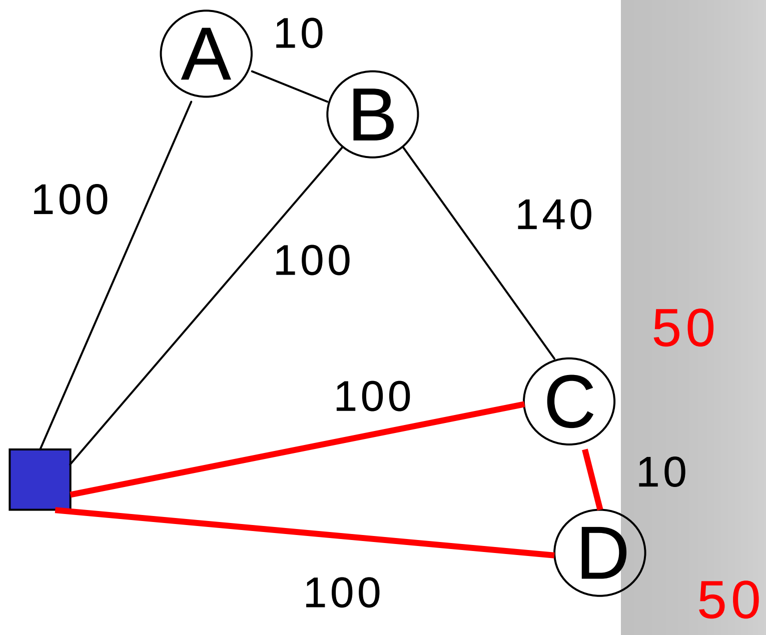
Day 1



Cost=210

The value of integration

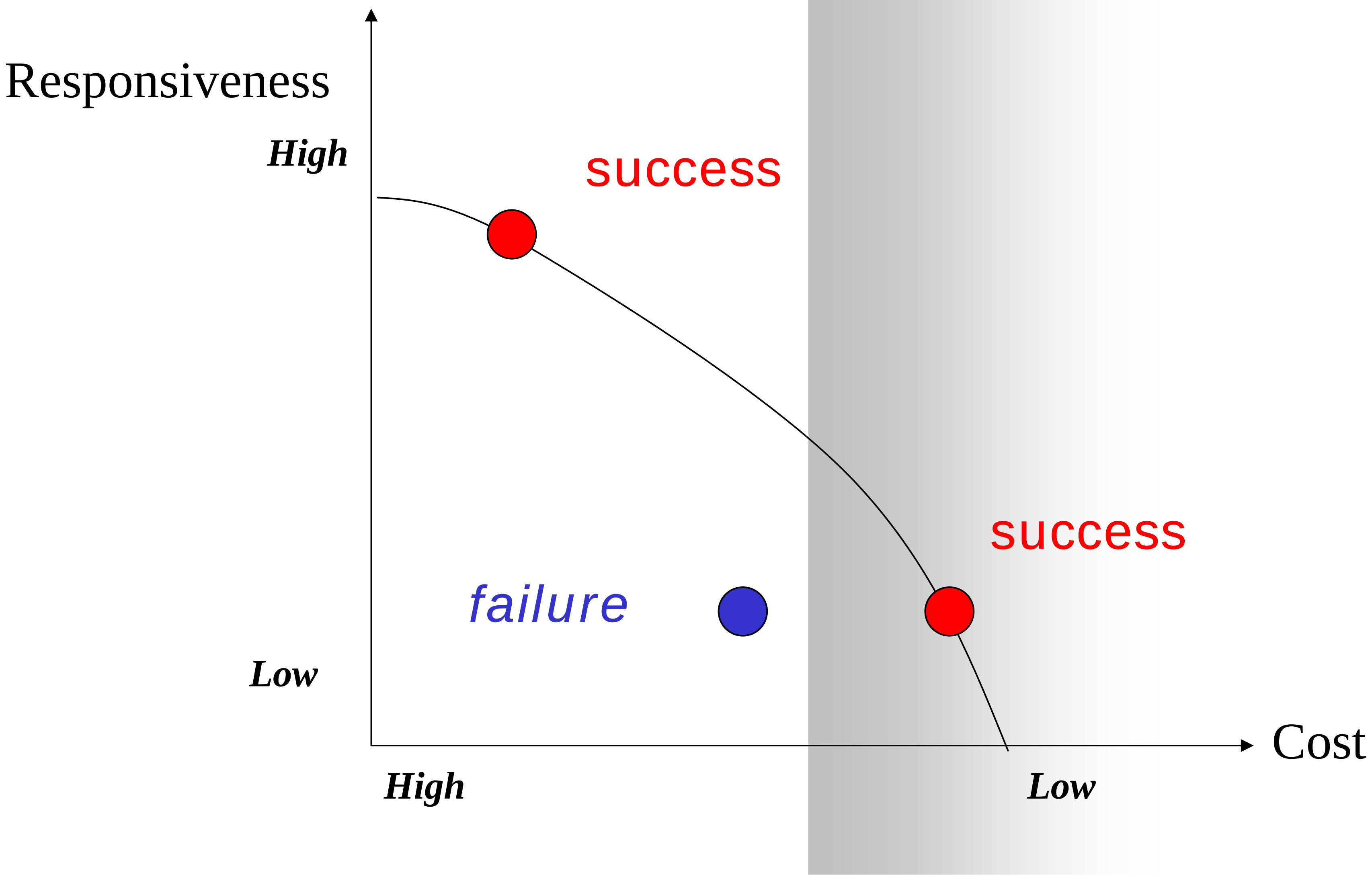
Day 2



Cost=210

Cost over two days=420
(against 700)

Efficient frontier



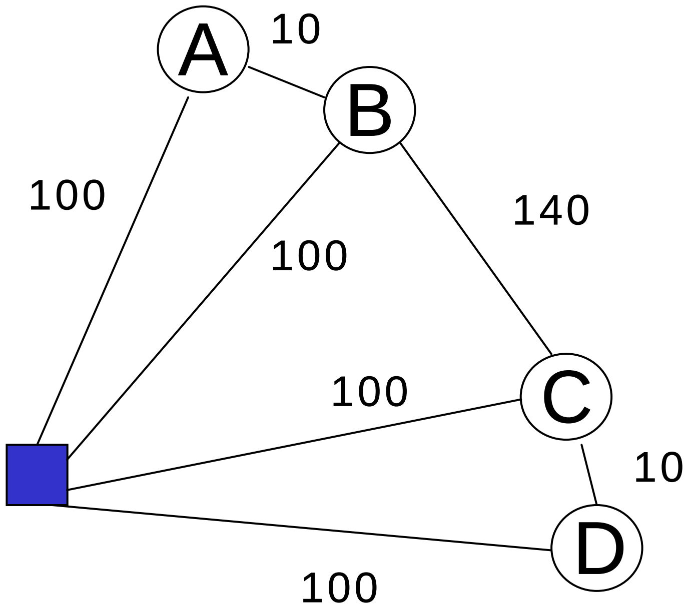
Efficiency and complexity

In global competition companies need to be on the efficient frontier

Intuition fails to generate efficient management policies

Need for integration and efficiency makes decision making more complex

Optimal policy

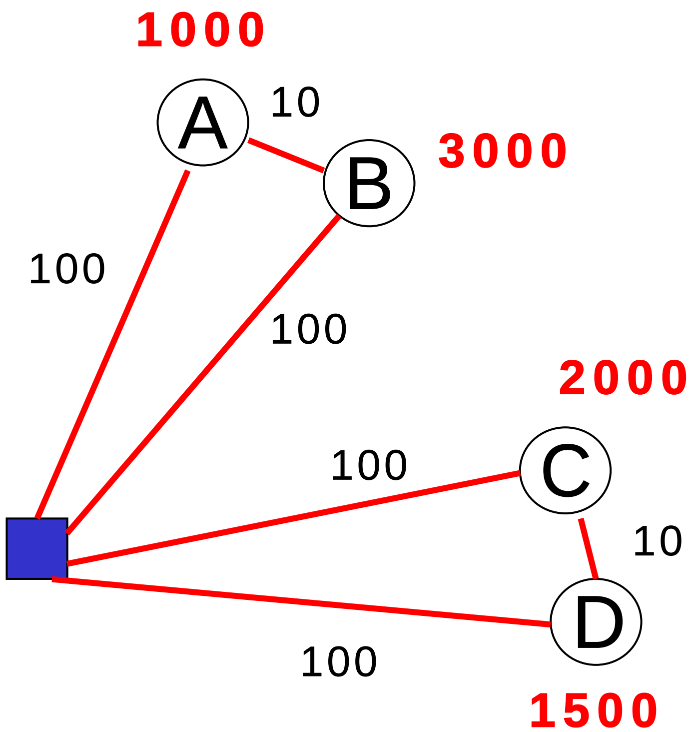


	capacity	demand
A	5000	1000
B	3000	3000
C	2000	2000
D	4000	1500

Initial inventory=capacity
The supplier has unlimited availability
Capacity of vehicles 5000
? Periodic policy of minimum transportation cost

Bell et al (1983), Interfaces

A natural solution

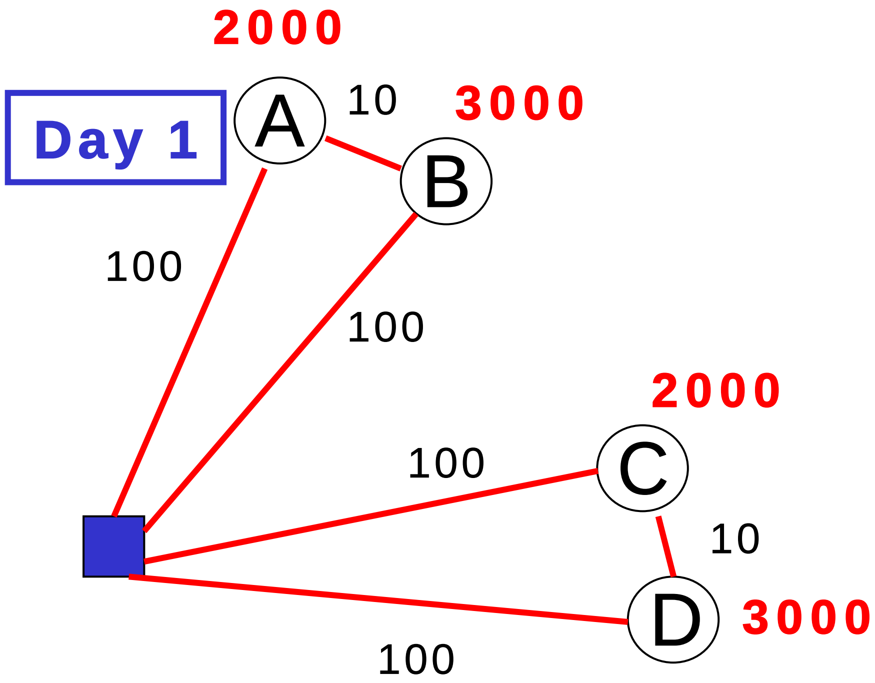


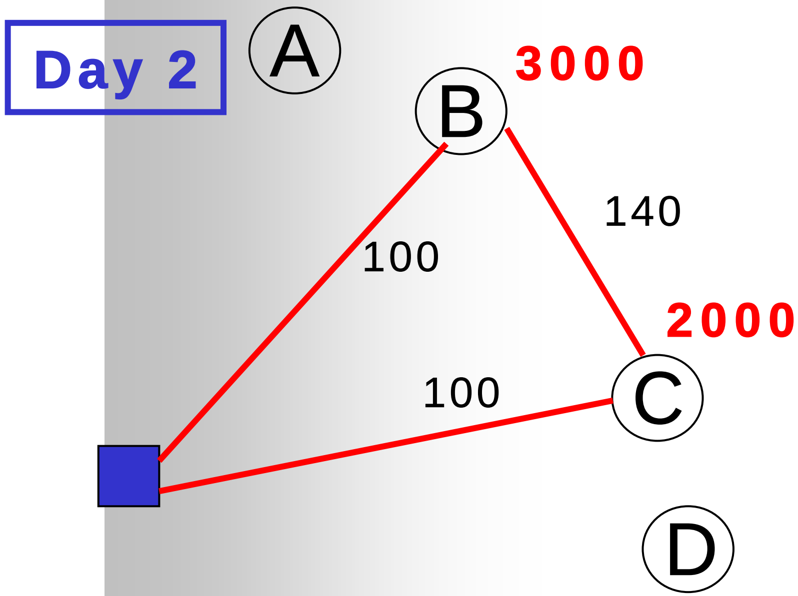
	capacity	demand
A	5000	1000
B	3000	3000
C	2000	2000
D	4000	1500

2 vehicles

Repeat the red and the green tours every day
Daily transportation cost: 420

A better solution

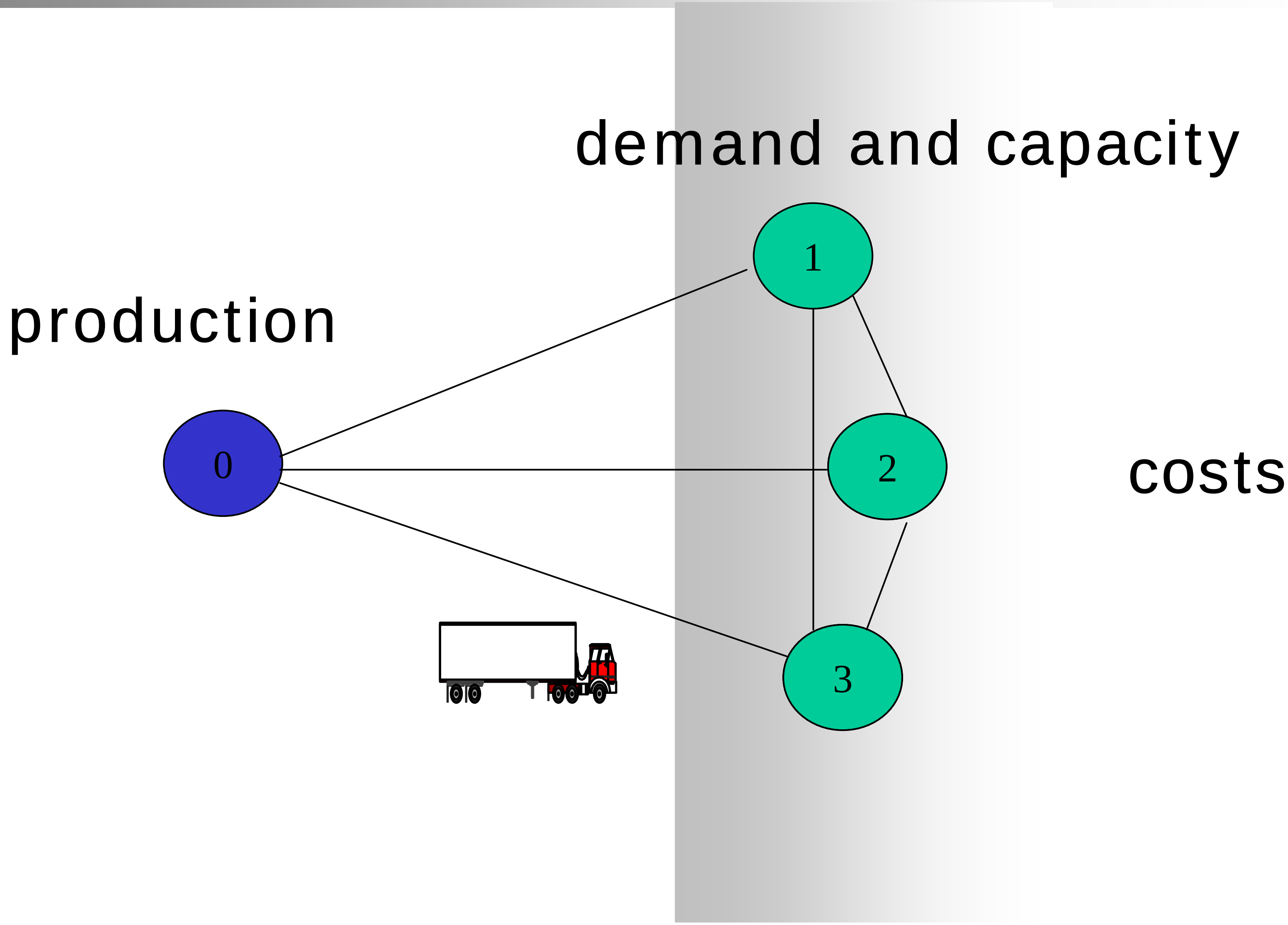




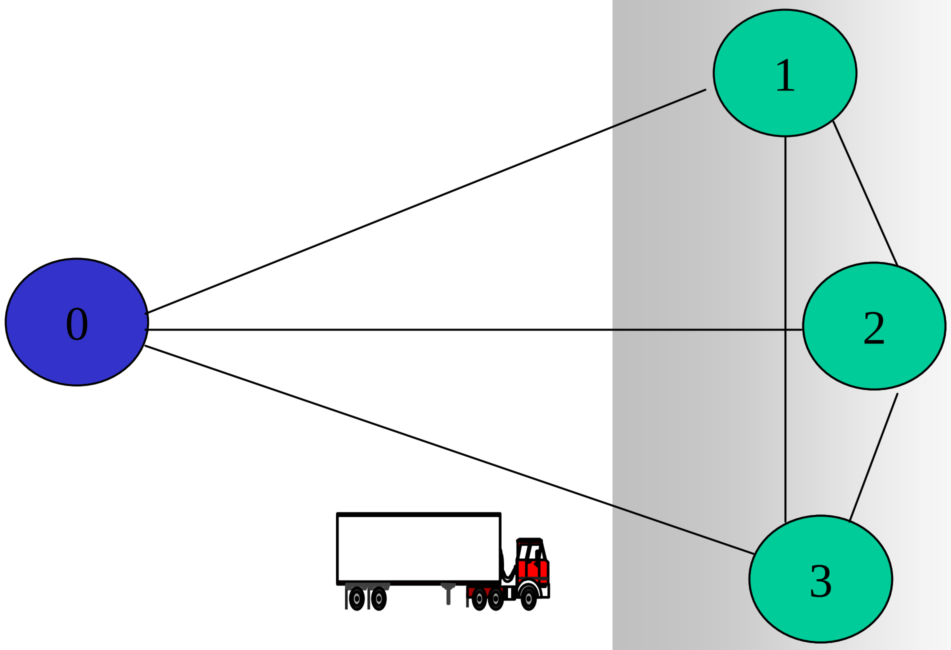
	capacity	consumption
A	5000	1000
B	3000	3000
C	2000	2000
D	4000	1500

Average daily transportation cost: 380

An integrated problem



An integrated problem

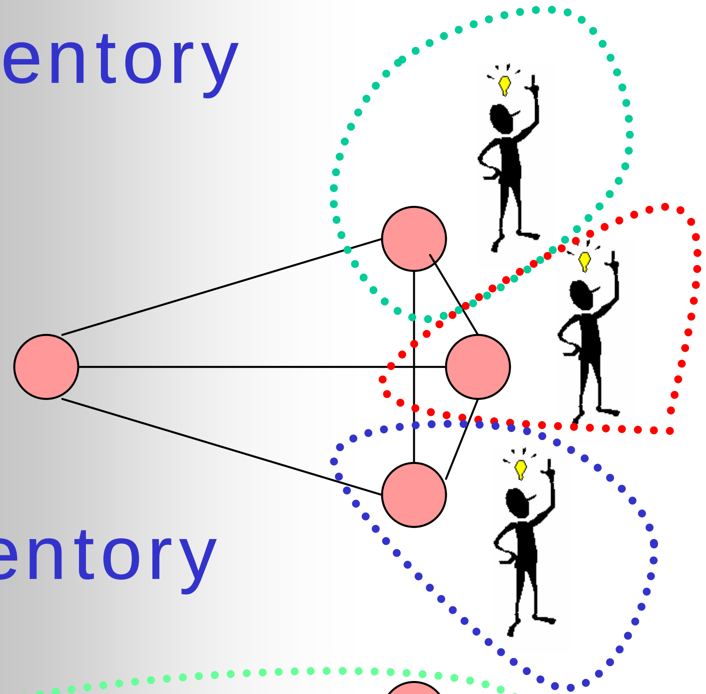


When and how much to produce?
When and how much to distribute?
Routes?
Goal: to minimize total cost

RMI vs VMI

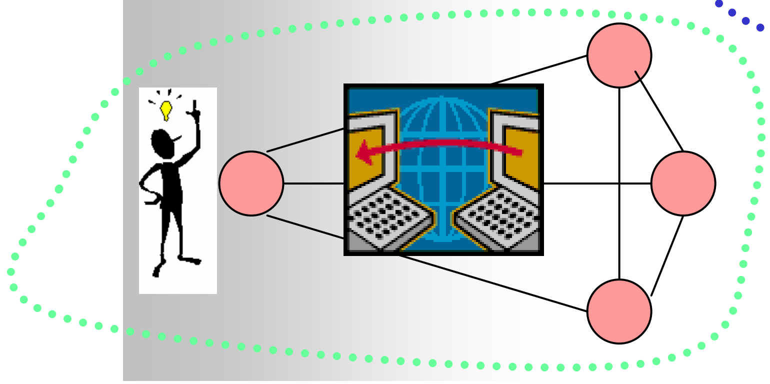
- RMI: Retailer-Managed Inventory

  Each retailer decides
  its replenishment policy



- VMI: Vendor-Managed Inventory

  The supplier monitors the
  inventory level of each
  retailer and decides
  the replenishment policy
  of each retailer



VMI vs RMI – the OU policy

	VMI Order-up
general case	71%
no fixed transportation cost	92%
small production cost	50%
no retailer inventory cost	67%

Cost of VMI with respect to RMI

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general case	71%
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no retailer inventory cost	67%

Cost of VMI with respect to RMI

Conclusions

- Integrated models are very complex
- Large savings can be achieved
- Appropriate models and algorithms (Operations research) are essential