IE 479 Distribution Logistics

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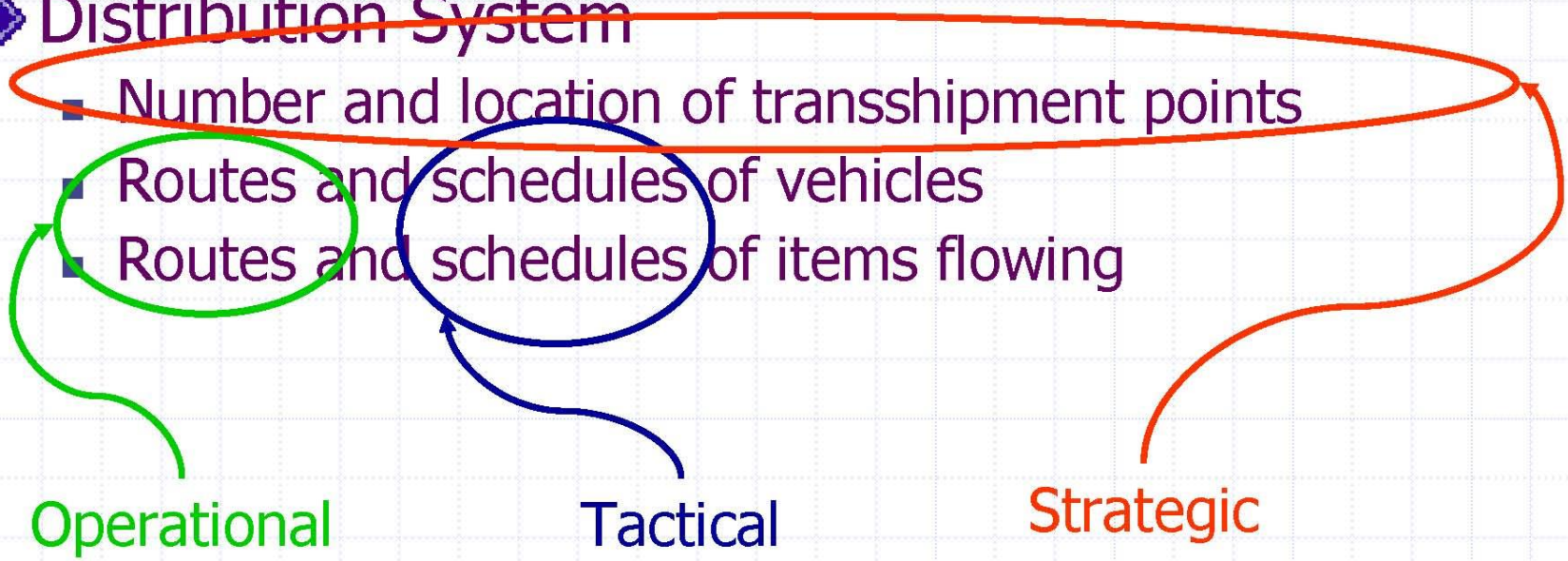
Distribution System Approach

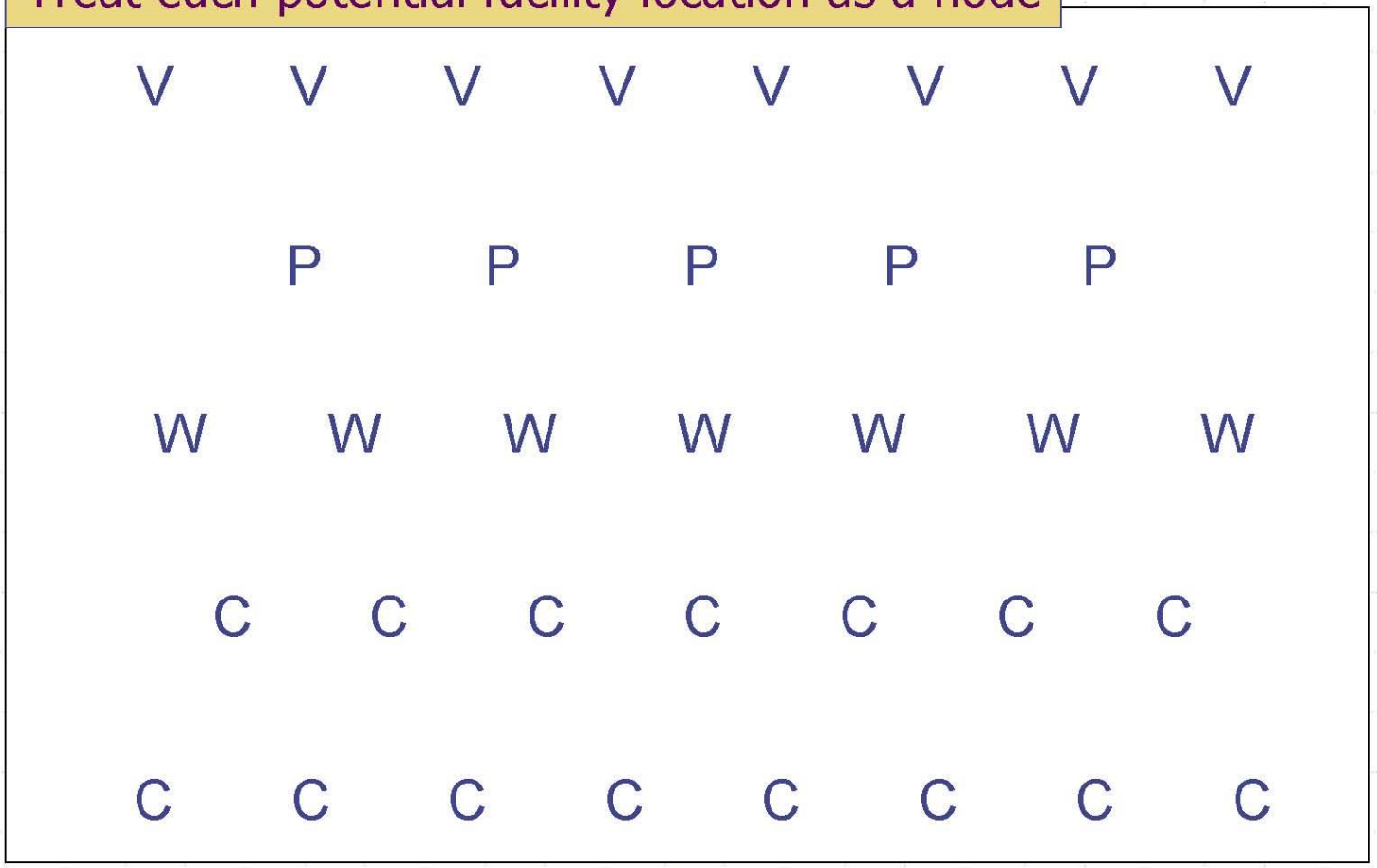
- Distribution System
  - Number and location of transshipment points
  - Routes and schedules of vehicles
  - Routes and schedules of items flowing



- Decisions made at different times
  - Strategic – longer scope and less data available (yr+)
  - Tactical – shorter scope w/ planning data (week to yr)
  - Operational – very short scope real data (daily)

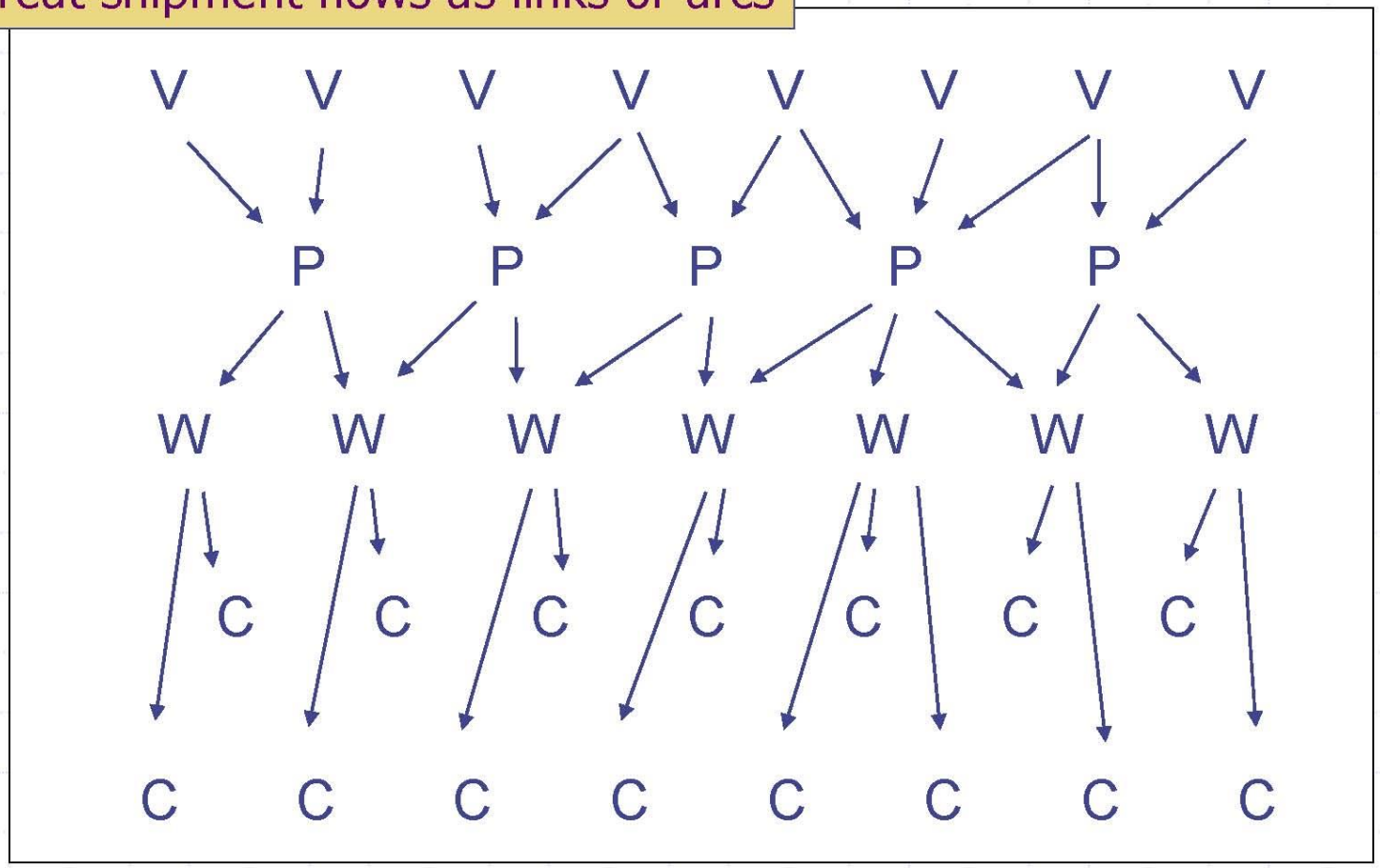
The Network Design Problem

Treat each potential facility location as a node



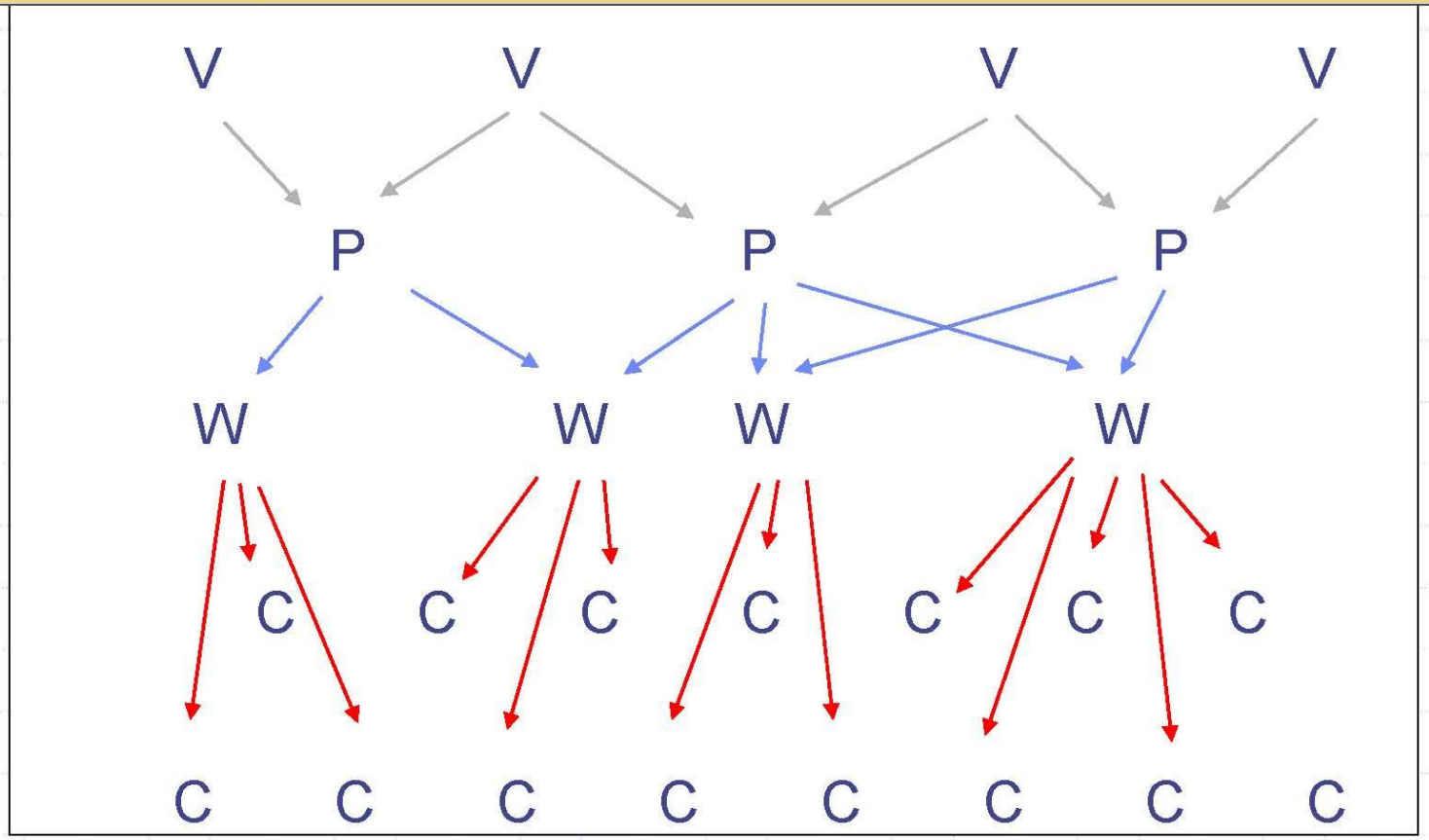
The Network Design Problem

Treat shipment flows as links or arcs



The Network Design Problem

Network design is the selection of nodes and links that minimize total cost



Distribution Network Design

- Three key questions for Distribution ND
  - How many DCs should there be?
  - Where should the DCs be located?
  - For each SKU and each customer:
    - which DC should serve the customer, and
    - which plant should serve the DC?

Distribution Network Design

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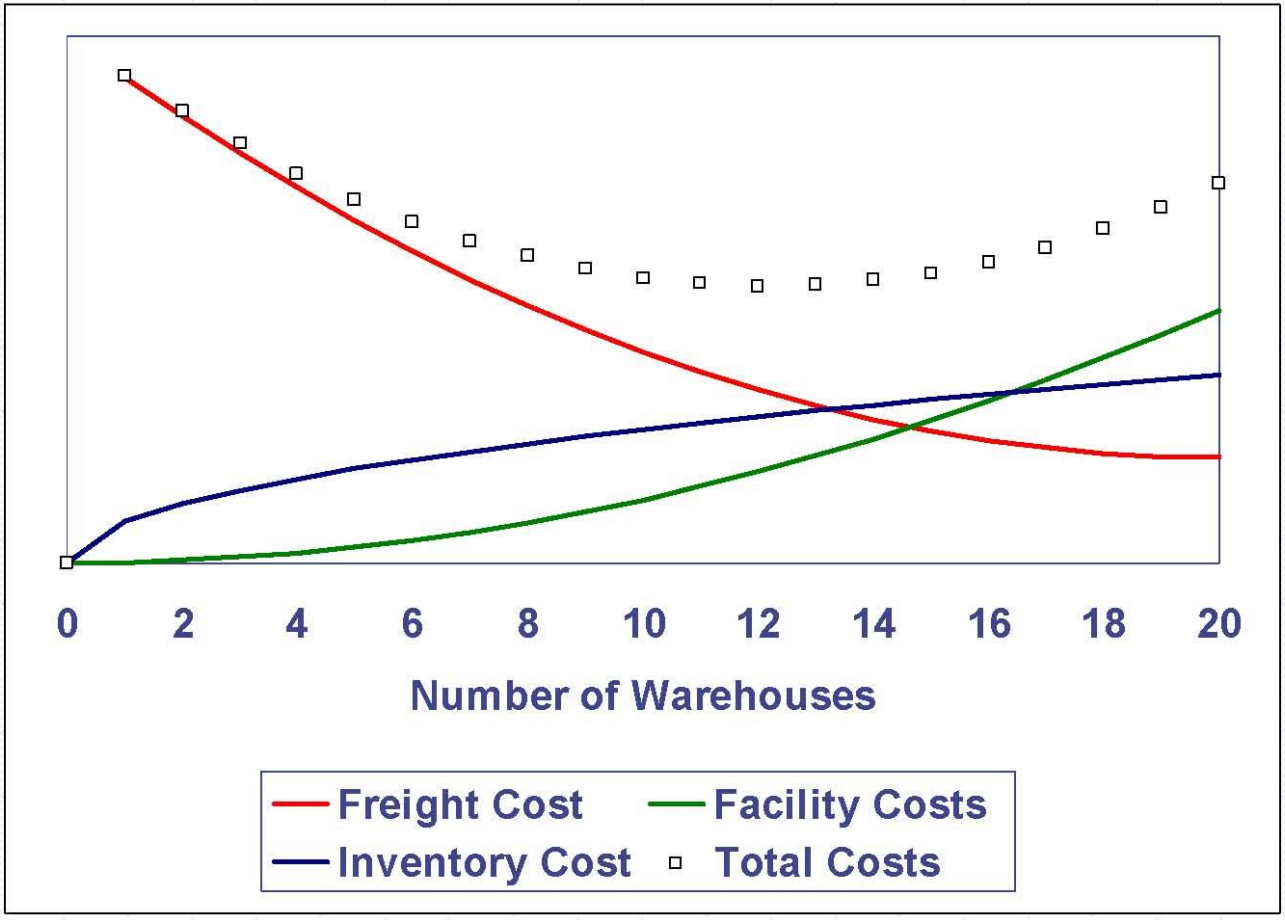
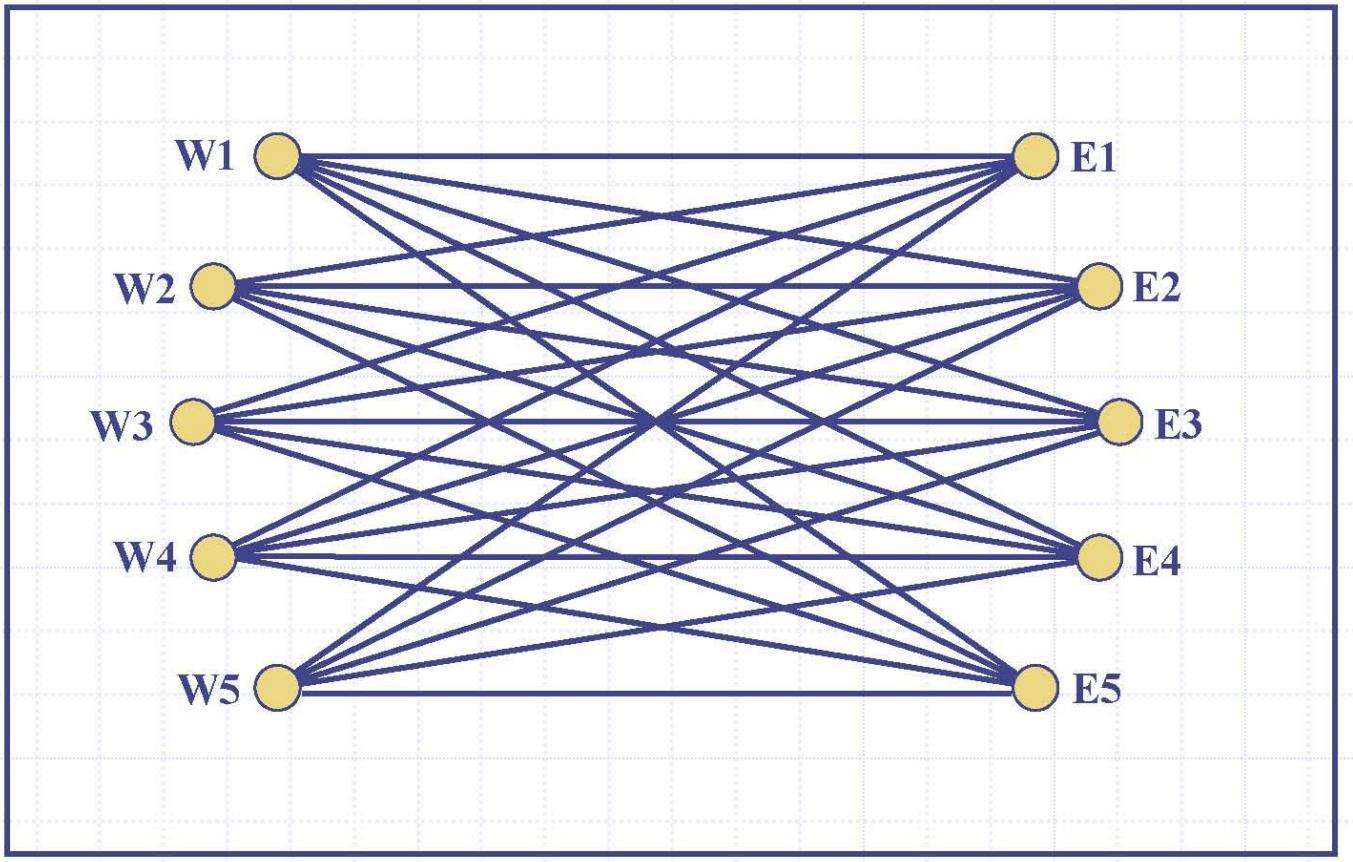
    - which plant should serve the DC?
- Cost & Performance Trade-Offs
  - Transportation Costs (Inbound versus Outbound)
  - Facility Costs (Fixed versus Throughput)
  - Inventory Costs (Cycle versus Safety Stock)
  - Customer Service (Availability versus Order Cycle Time)

Facility Location Cost Trade-Offs



Many to Many Networks

How should I ship from 5 origins to 5 destinations?



Direct Network

Many to Many Networks

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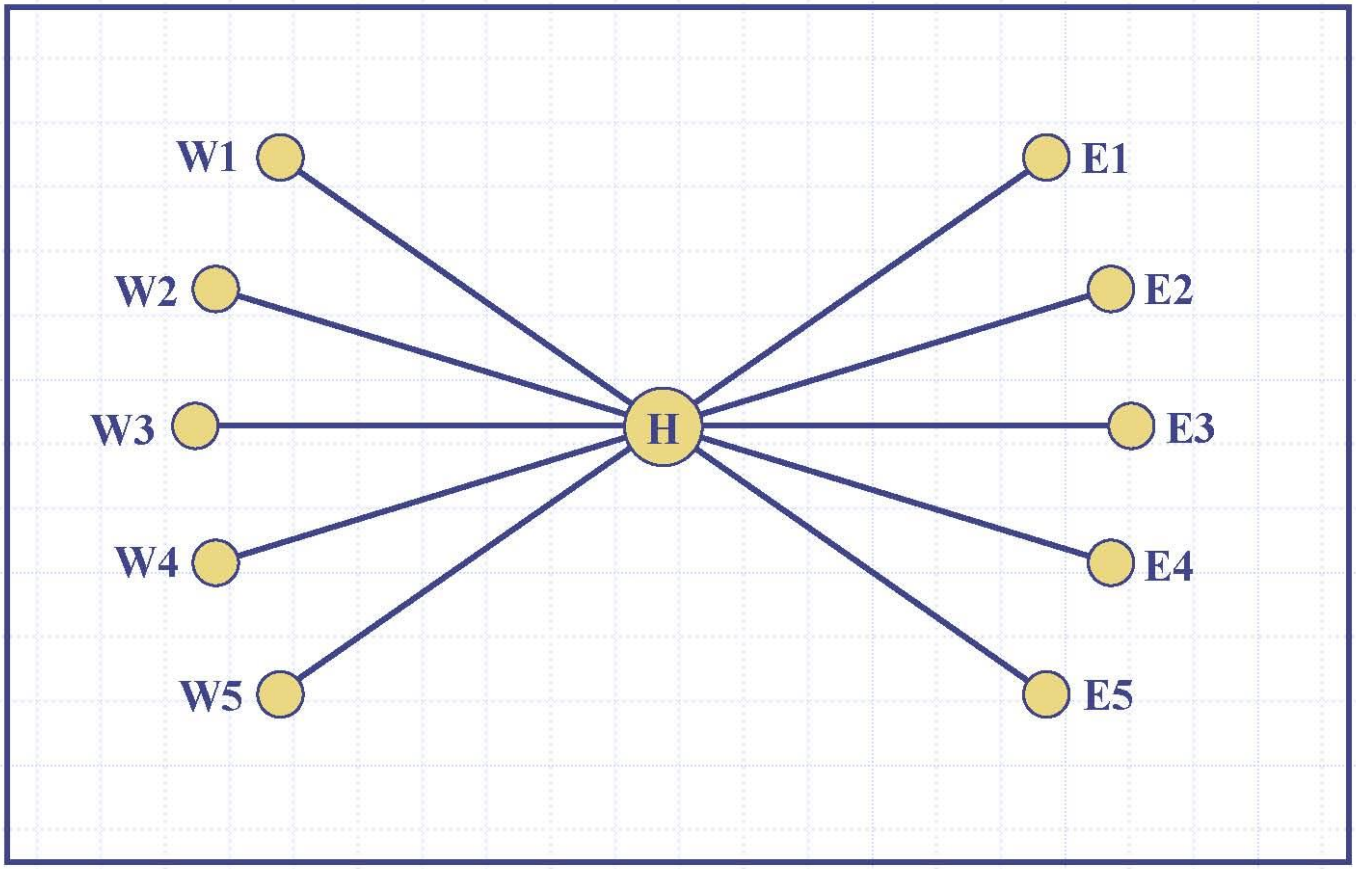


Hub & Spoke Network

Direct versus Hub

- Which is better?
  - How many trucks are needed?
  - What is the cost?
  - How can I increase frequency of service?

- Example Details
  - Need to pick up every day from terminals
  - Average distance between terminals = 500 miles
  - Average distance from terminals to hub = 350 miles
  - Cost for transportation = $200 shipment + 1 $/mile

Hub Advantages

- Hub consolidation reduces costs
  - Consolidation increases conveyance utilization
  - Transportation has a fixed (per conveyance) cost
- Fewer conveyances are required
  - Is consolidation better . . .

- Provides better level of service with fewer resources
  - Non-stop vs. frequency of service
  - Non-stop vs. geographical coverage
    - serving more / smaller cities

Hub Disadvantages

- Cost of operating the hub
  - Facility costs
  - Handling costs - unloading, sorting, loading
  - Opportunity for misrouting, damage, theft (shrinkage)
- Circuity
  - Longer total distance travelled
  - More vehicle-hours expended
- Impact on service levels
  - Added time in-transit
  - Lower reliability of transit

Hub Economics

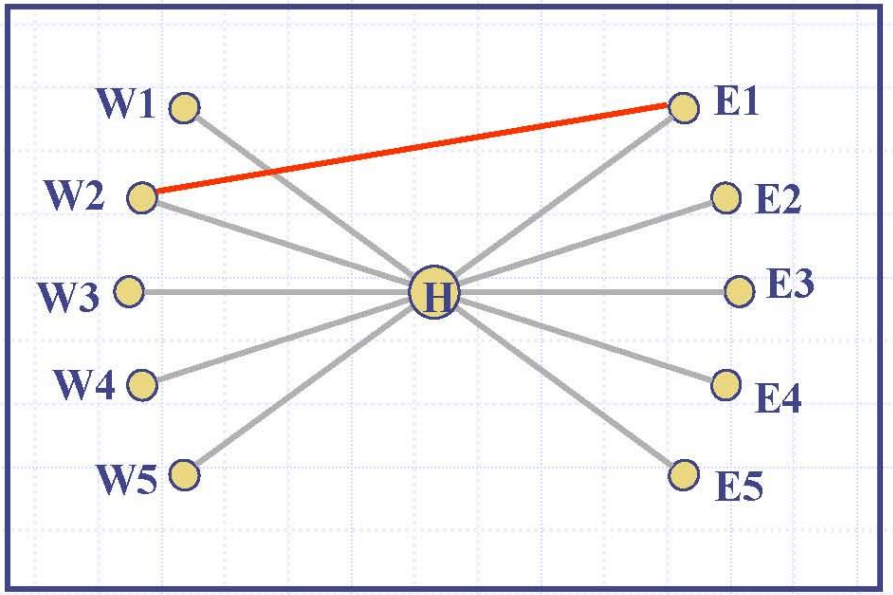
- Relative distances
  - Degree of circuity
- Vehicle and shipment size
  - Smaller shipments → hub more economical
- Demand pattern
  - Many destinations from each origin
  - Many origins into each destination
- The hub location
  - Significant business generation for passengers
  - Good access for freight
    - Highways access
    - Away from population centers

Terminal Bypass Operations

- When would you want to bypass hub handling?
- Examples
  - Air - through flight
    - Use heaviest pair
    - Marketing; reliability; lower costs
  - LTL - "head loading"
  - Rail - block placement
  - Parcel - pre-packaging
- Packages physically travel to the hub, but are not touched or handled.

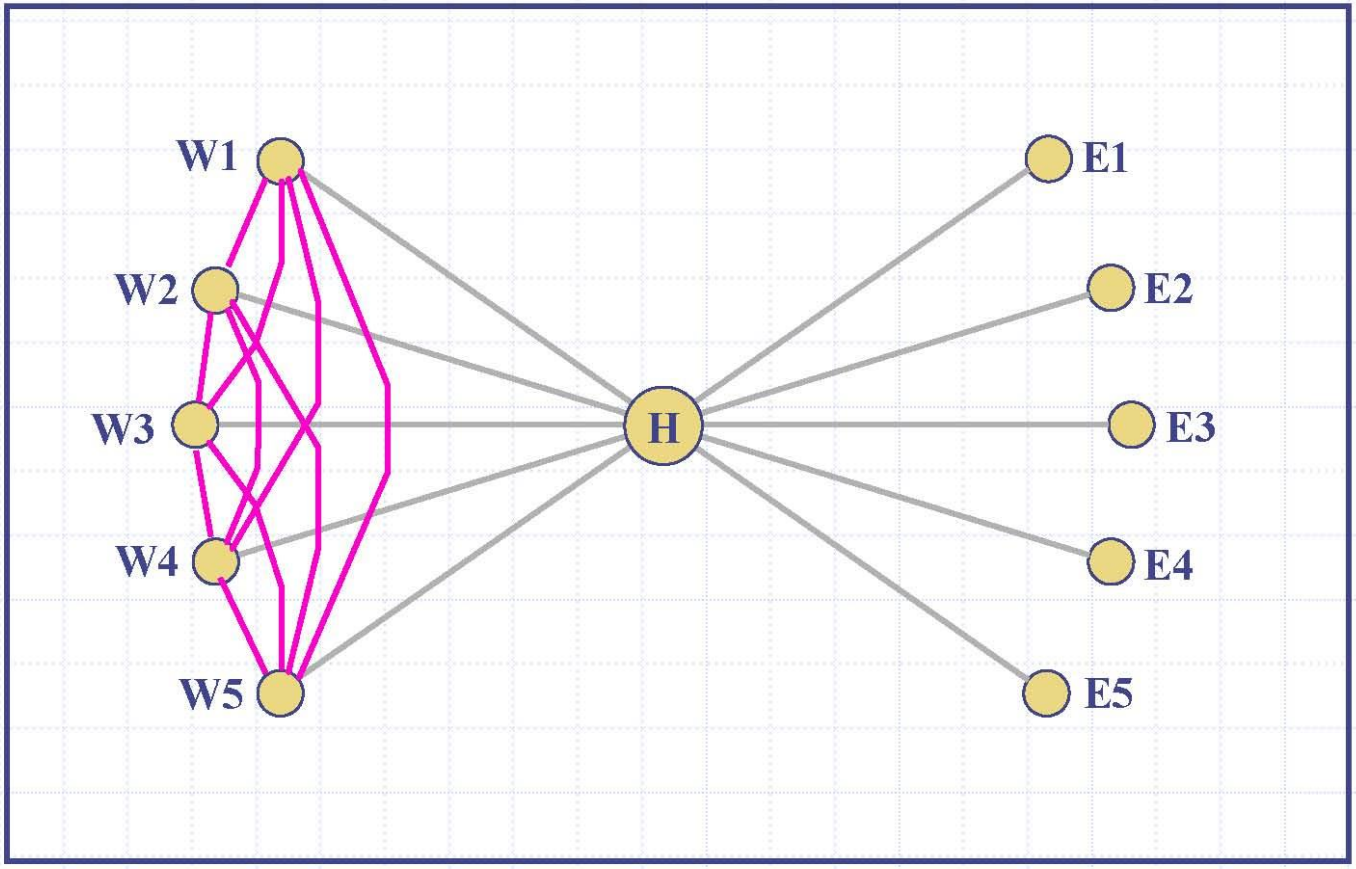
Directs in a Hub-and-Spoke Network

- Considerations in setting direct service:
  - Demand between E1 and W2
  - Service E1-Hub and Hub-W2
  - Effect on the hub
  - Effect on E1 activities

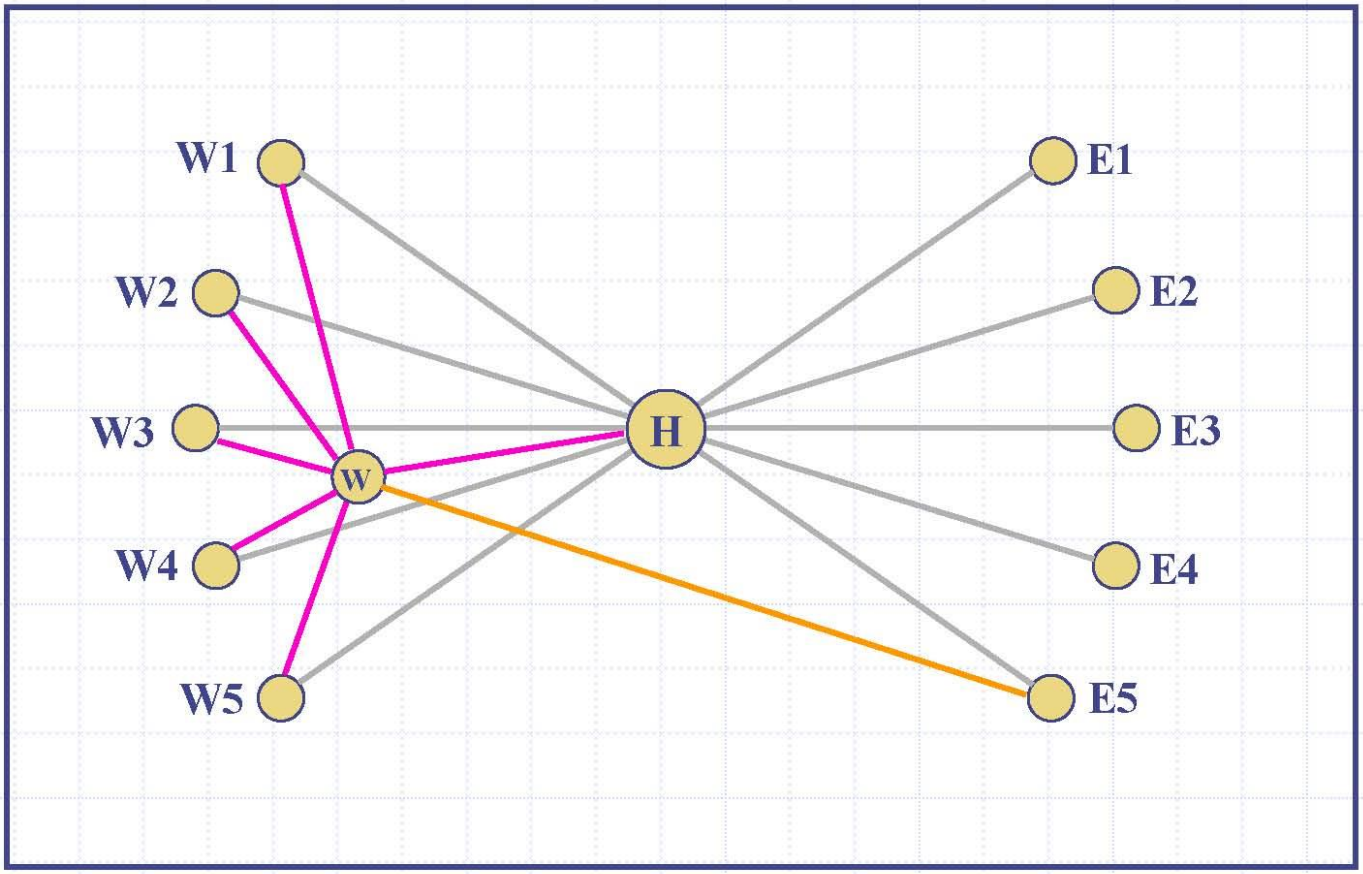


Regional Terminals

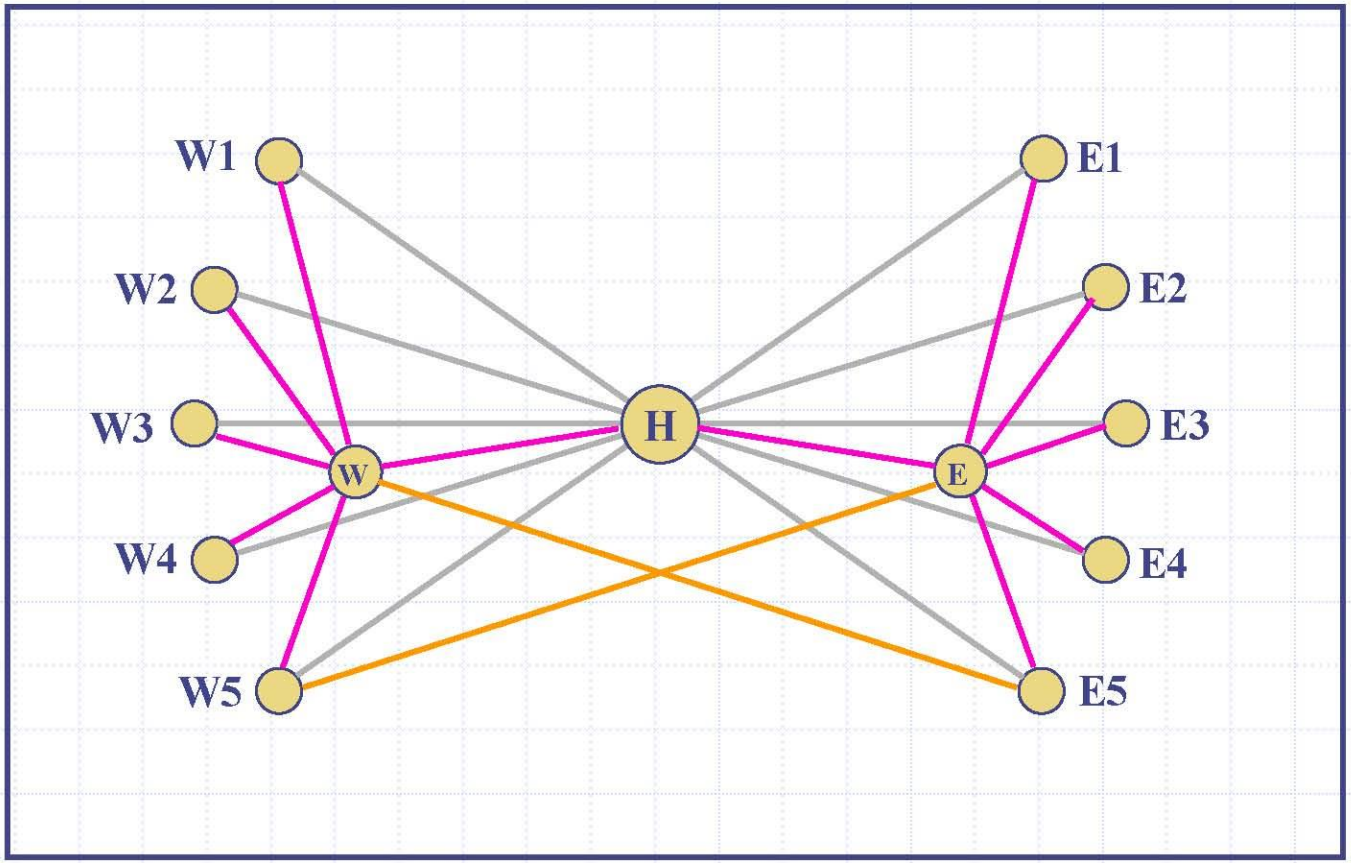
What if there is demand between the W terminals?



Bypassing the Hub



More Routing Alternatives

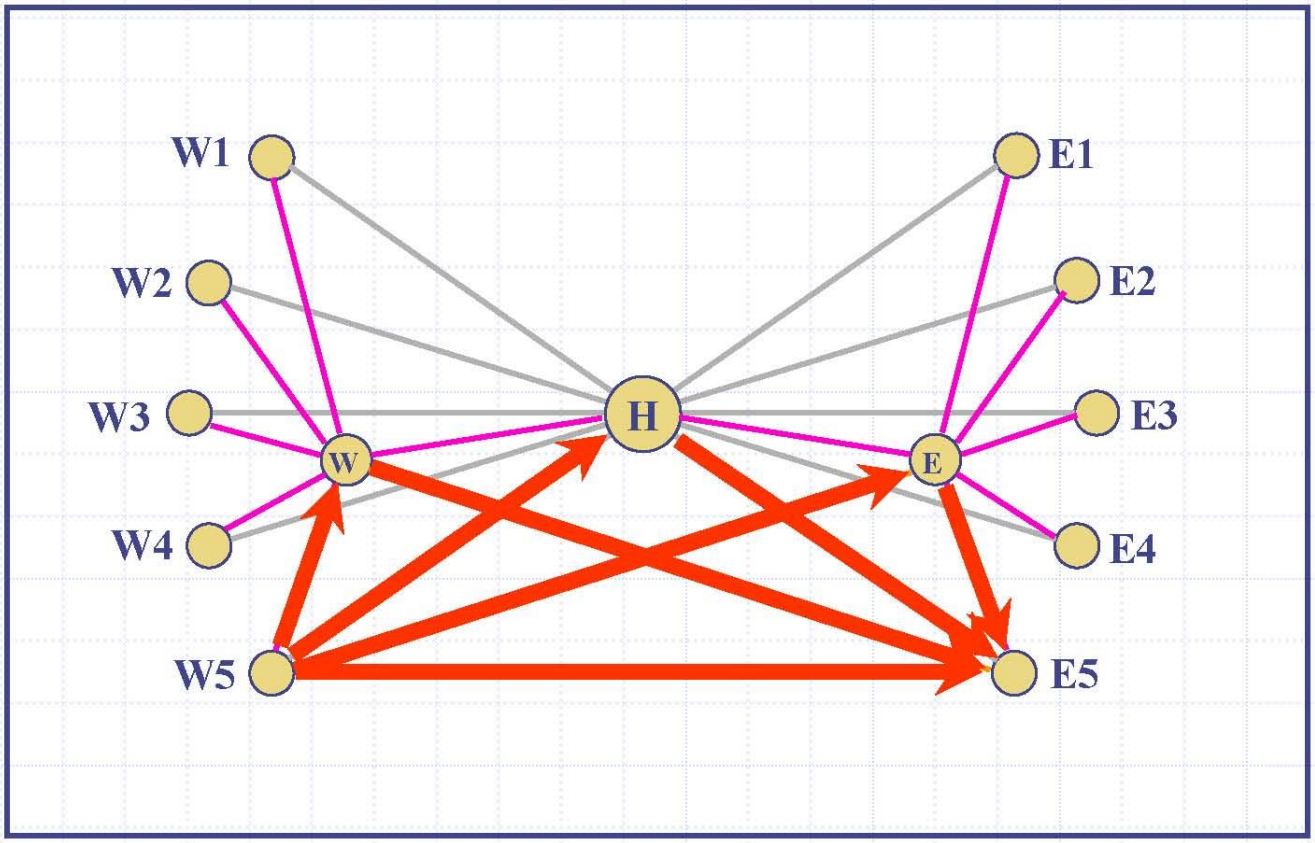


More Routing Alternatives

Routings:
- W5-W-E5
- W5-H-E5
- W5-E-E5
- W5 – E5

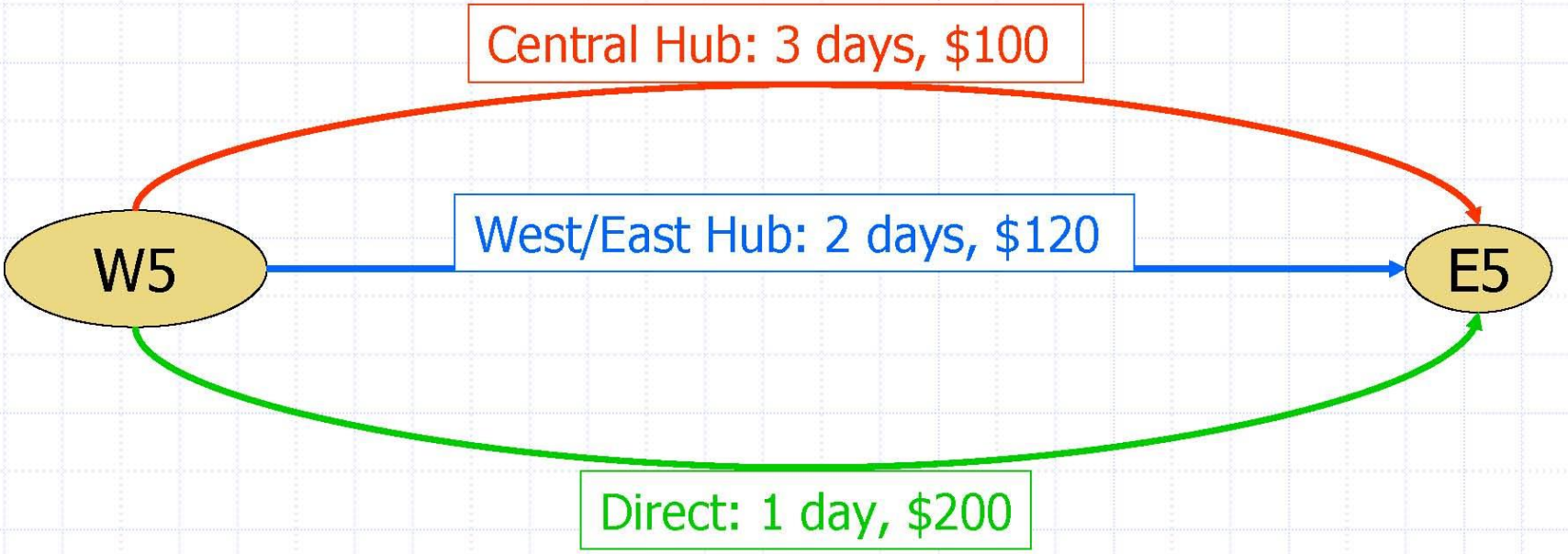
Direct effects:
- On each of the three alternatives

Indirect effects:
- Congestion and spill-overs



Strategic Network

- Service Offerings from W5 to E5
  - Central Hub Routing
  - Regional Terminal Routing
  - Direct Routing



Network Structure Tradeoffs

Structure	Pros	Cons
Direct Shipping	◆No intermediate DCs ◆Simple to coordinate	◆Large lot sizes (high inventory levels) ◆Large receiving expense
Direct w/ Milk Runs	◆Lower transport costs for smaller shipments ◆Lower inventory levels	◆Increased coordination complexity
Direct w/Central DC (holding inventory)	◆Lower IB transport costs (consolidation)	◆Increased inventory costs ◆Increased handling at DC
Direct w/ Central DC (X-dock)	◆Very low inventory requirements ◆Lower IB transport costs (consolidation)	◆Increased coordination complexity
DC w/ Milk Runs	◆Lower OB transport costs for smaller shipments	◆Further increase in complexity
Hybrid System	◆Best fit of structure for business ◆Customized for product, customer mix	◆Exceptionally high level of complexity for planning and execution

Source: Chopra & Meindl 2004

Network Structure Drivers

	Short Distance	Medium Distance	Long Distance
High Density	◆Pvt fleet with milk runs	◆X-dock with milk runs	◆X-dock with milk runs
Medium Density	◆Third Party Milk Runs	◆LTL Carrier	◆LTL or Package Carrier
Low Density	◆Third Party Milk Runs or LTL Carrier	◆LTL or Package Carrier	◆Package Carrier

Customer density versus Length of Haul

Distribution System Approach

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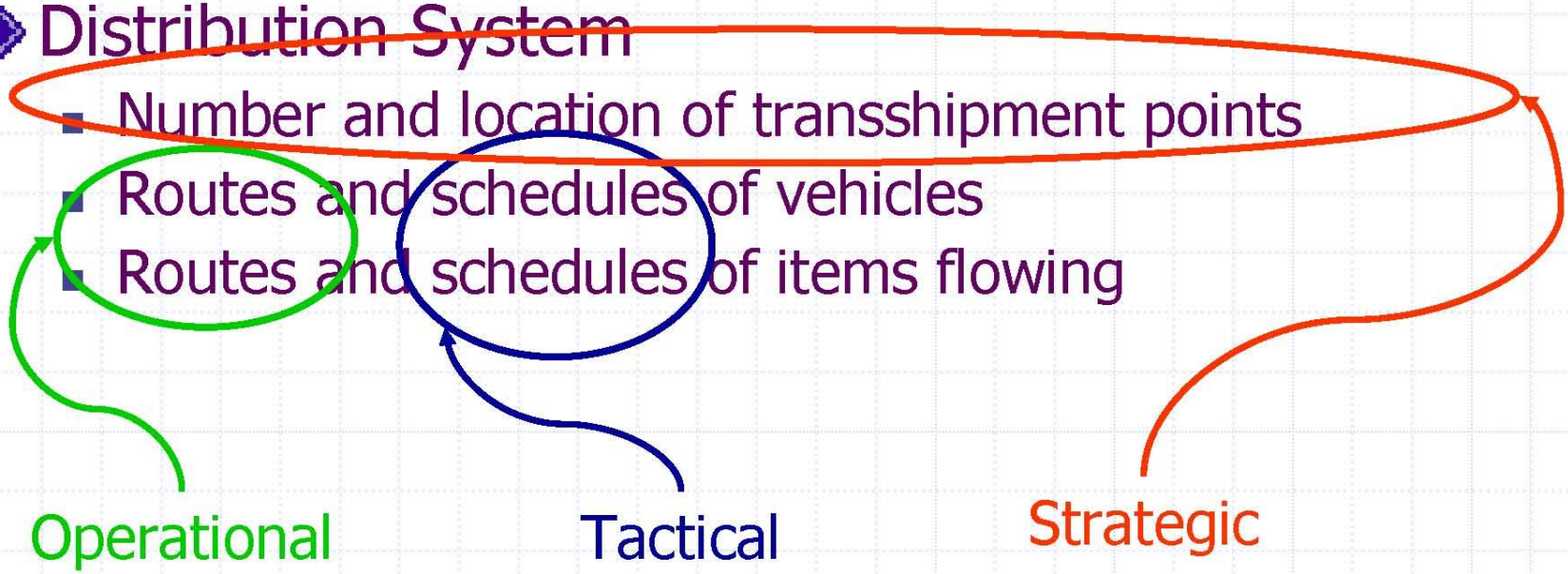

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Course Outline

- Book categorizes the decisions in five main streams :
  - Forecasting
  - Designing logistics networks ch.3 — Strategic
  - Managing inventories
  - Warehouse management
  - Planning and controlling
    - long-haul ch.6 — Tactical
    - short-haul transportation ch.7 — Operational

Designing the Logistics Network

- May involve
  - Determining the number of facilities (retailers, distirbution centers, warehouses etc)
  - Determining the location of each facility
  - Determining the size of each facility
  - Allocations
  - Transport modes
  - Etc.

Different types of facilities

- Manufacturing plants
- Distribution centers (DCs)
  - Reducing lead times
  - Increasing product availability
  - Economies pf scale through consolidation
  - Level of support for emergency orders
  - Consolidation point for reverse logistics
- Retailers

Applications in 3 levels

- Strategic level (Not easy to undone)
  - Airport
  - Metro system
  - Major manufacturing facility
- Tactical level (Should be good for 5 to 10 years)
  - Warehose
  - McDonalds
  - Buslines
- Operational level
  - Post boxes
  - Transfer points for trucks

Logistics Network Design

- Objectives and criteria vary depending on the sector and on the type of facilities (DCs, plants, etc)
- Criteria
  - Location availability
  - Cost
  - Accessibility
  - Coverage
  - Market share
  - Anti-accessibility (dump sites, bomb testing)

Location Problems

- Suggest and identify options for
  - Number
  - Location
  - Size of facilities
  - Allocation of demands (supplies) to facilities

Classification of Location Problems

- Time
  - Single period
  - Multiple period
- Facility Topology
  - Single type (homogenous)
  - Multi-type
- Material
  - Single commodity
  - Multi commodity
- Interaction Among Facilities
  - Allowed
  - Not allowed
- Dominant material flow
  - Single echelon (either the material flow coming out or entering the facility is negligible)
  - Multi-echelon (both inbound and outbound traffic is valid)
- Demand divisibility
  - Single allocation (each facility or customer be supplied by a single center) indivisible demand
  - Multi-allocation (may be served by > 1 denters) divisible demand

Single Echelon Single Commodity Location Models