1.224J/ESD.204J TRANSPORTATION OPERATIONS, PLANNING AND CONTROL: CARRIER SYSTEMS

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Fall 2003

1.224J/ ESD.204J

Outline

- Sign-up Sheet
  - Introductions
- Carrier Systems Overview
- Course Overview
  - Syllabus

Course Objective #1

Provide an understanding of carrier systems

Carrier Systems

- Transportation service networks
  - Warehouses/ Consolidation centers/ Hubs/Yards
  - Dock doors, gates
- Assets
  - Vehicles
  - Personnel/ Crews
  - Handling equipment
- Movement requirements
  - Freight
  - Passengers

Design
Operation
Management

Carrier Problems: Core Components

- Time and Space Considerations
  - Large-Scale Problems
- Discrete Conveyances and Personnel
  - Integrality Requirements
- Networked operations
  - Inter-related decisions
- Non-linear and Flow-dependent Costs
  - Non-linear, complex interdependencies

Some Examples

Less-Than-Truckload Operational Load Planning

- Given:
  - Tractor, trailer, load, driver routes and schedules
  - Real-time information describing status of the system
- Find:
  - New tractor, trailer, load, and driver routes and schedules to minimize costs and satisfy service requirements given current system status and limited knowledge of future status

Rail Yard Modeling

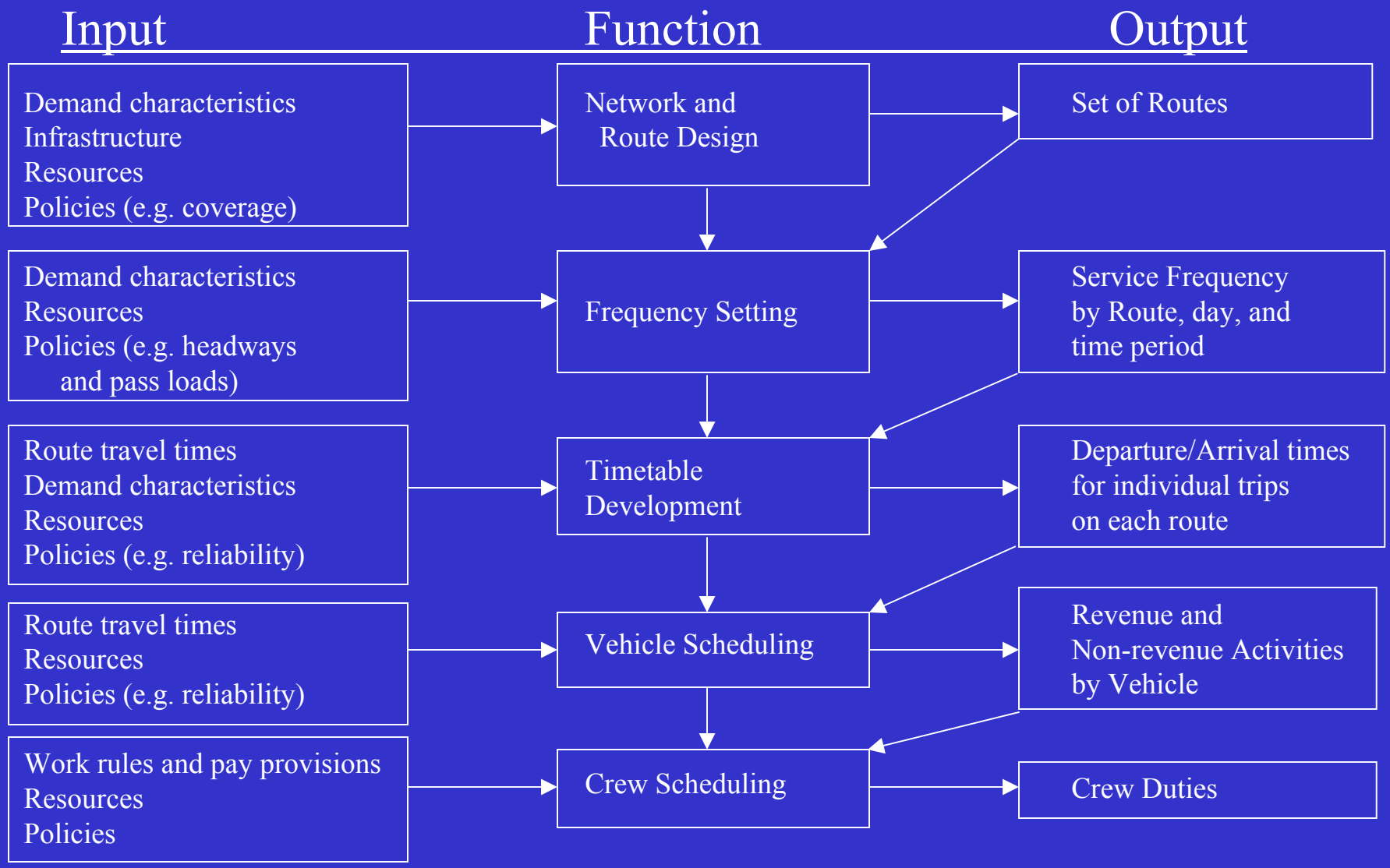
- Given:
  - Operations at an inter-modal rail yard
  - Available resources
- Develop:
  - Simulation of yard activities
    - Describe/ evaluate yard performance and resource utilization
  - Optimization-based strategies to improve yard performance

Airline Fleet Assignments

- Given:
  - Flight schedule
    - Flight legs
    - Departure times
  - Fleets (aircraft types)
    - Operating and carrying costs per flight leg
    - Number of aircraft
    - Operating characteristics
  - Passenger itinerary demand
    - Itinerary fares
- Develop:
  - Minimum cost assignment of aircraft types to flight legs
    - Each flight is assigned exactly one fleet type
    - Only available aircraft of each type are assigned
    - Aircraft balance is achieved, by location

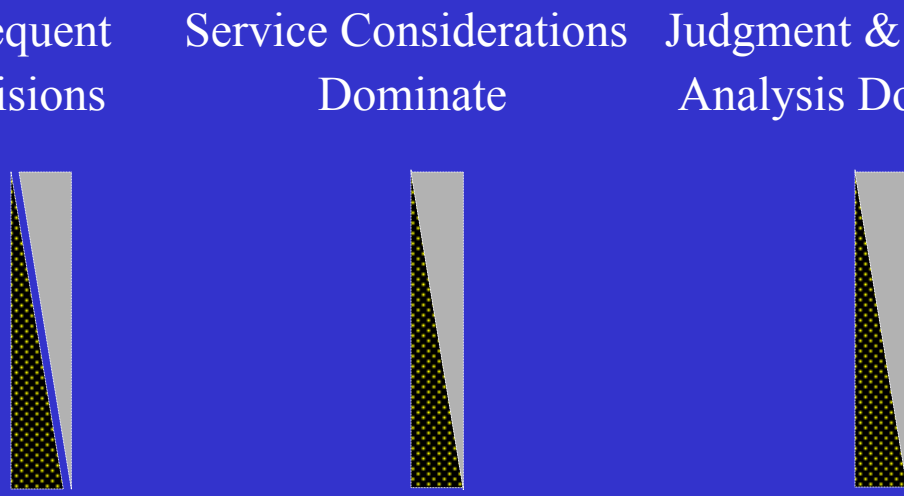
The Overall Planning Process

Service Planning Hierarchy

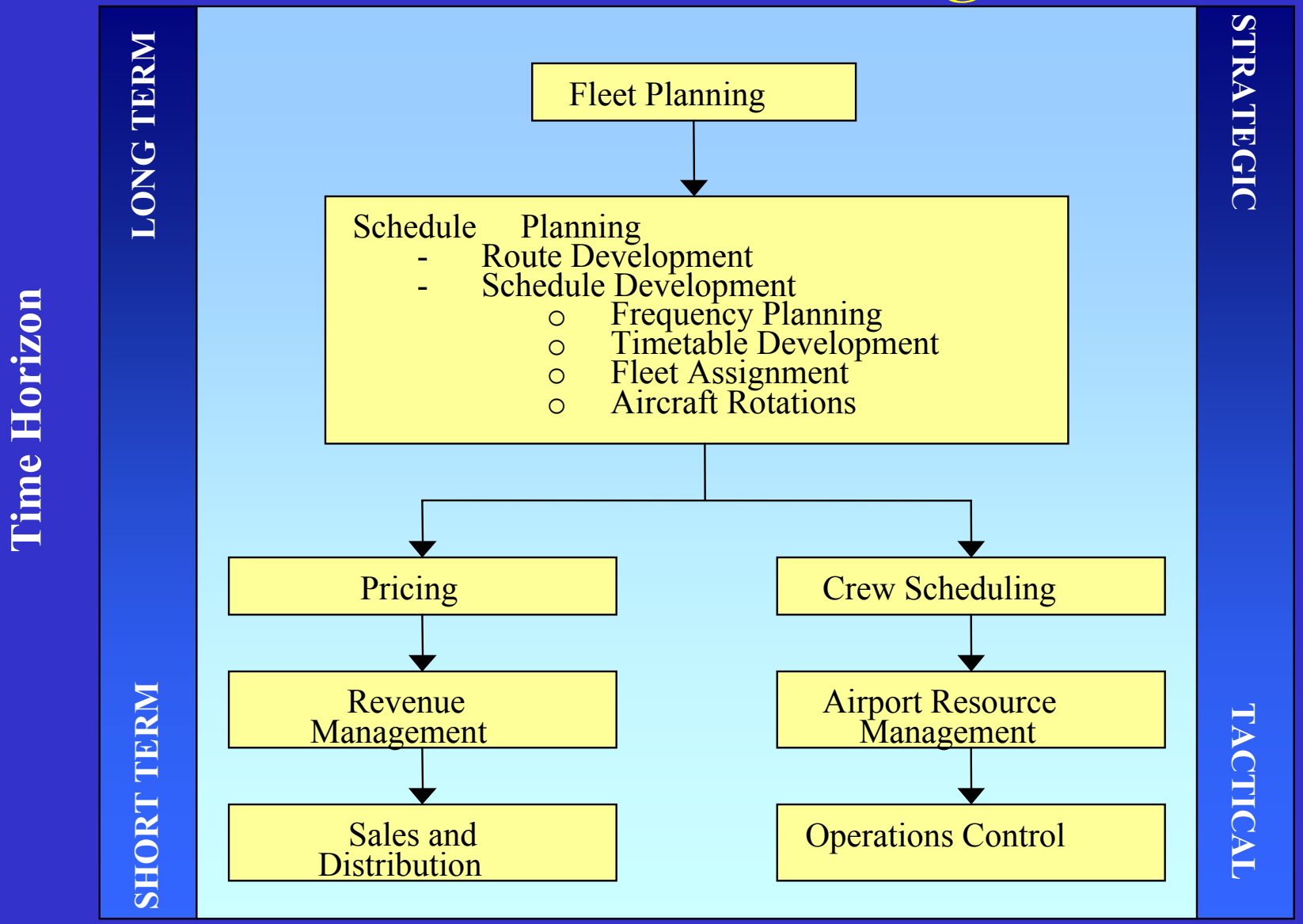


Service Planning Hierarchy

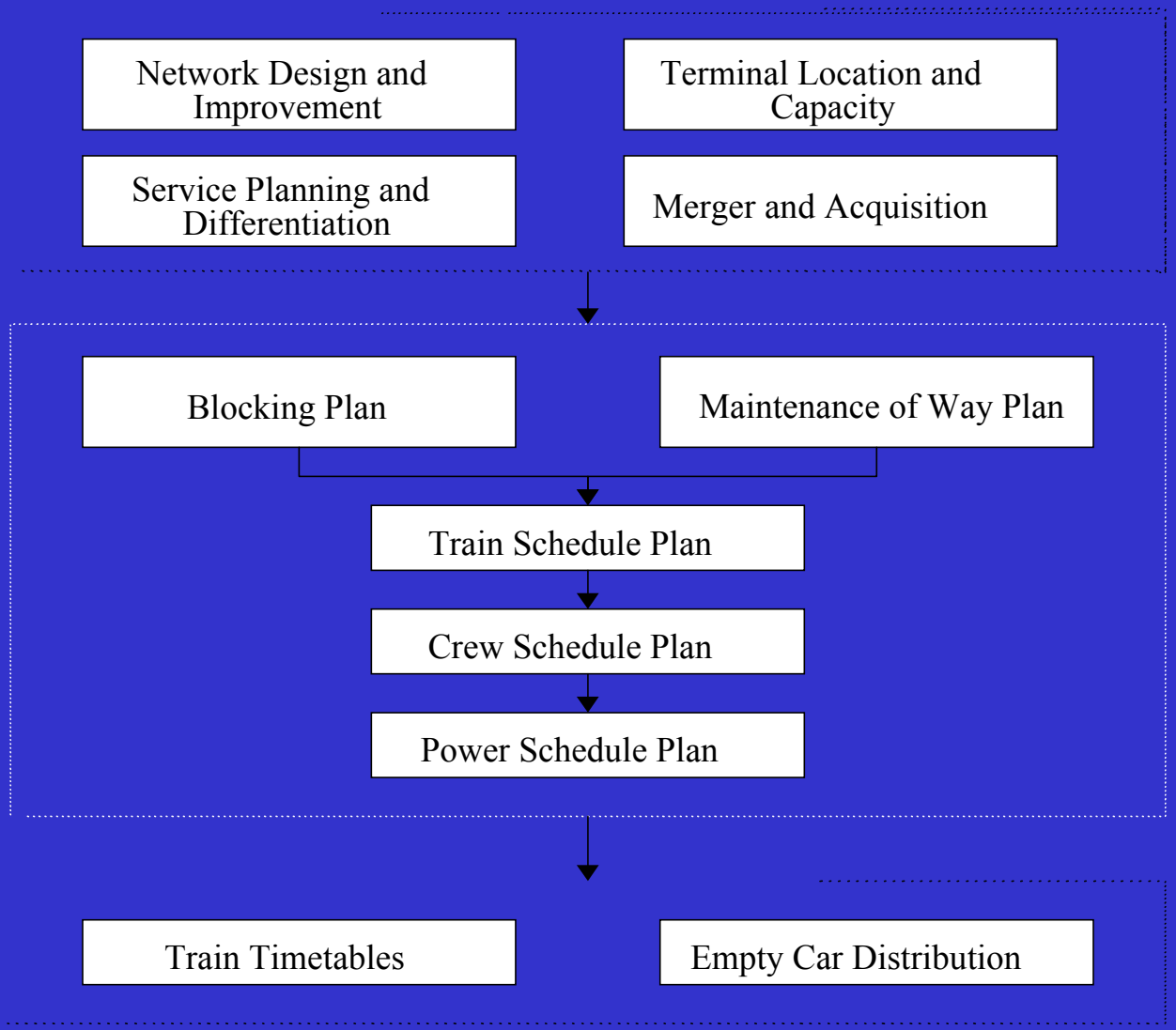
Network Design
Frequency Setting
Timetable Development
Vehicle Scheduling
Crew Scheduling



Airline Planning



Railroad Planning



Strategic Plans

Tactical Plans

Operational Plans

Course Objective #2

Demonstrate how to develop, solve and interpret the results of optimization models and algorithms applied to carrier systems

– Decision and policy making aids for large-scale, complex transportation systems

Why Mathematical Modeling and Automated Solutions?

- Carrier problems are large scale, complex problems
- Intuition fails to produce "optimal," or possibly "feasible" solutions
- Generating feasible solutions manually can be very time consuming
- Without decision support technology, scenario analysis is limited or impossible

Approach

- Overview of optimization modeling
- Case studies/ applications
  - Provide representative examples of the types of carrier problems, and their complexity
  - Allows development of the "art" of problem formulation and modeling
    - Exactness vs. tractability trade-offs
  - Provide hands-on opportunities to apply the "science" of optimization

Case Studies

- ***Context:***
  - Transportation procurement/ direct transportation in logistics
  - Transit vehicle and crew scheduling
  - Airline crew and aircraft maintenance routing

- ***Models:***
  - Network representations
  - Linear programs
  - (Mixed) integer programs

Methods

- Problem classification as “easy” or “hard”
- Use of LP and IP solvers
  - Simplex method
  - Branch-and-bound
- Decomposition techniques
- Heuristic strategies
- Sensitivity analysis
  - Shadow prices, reduced costs and complementary slackness

Syllabus
& Academic Honesty Policy