Yard Optimization at Sea Container Terminals

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Outline

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- Terminal overview

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Introduction

- Growth of container sea-freight transportation.

- Competition among terminals in terms of:
    - Service (ship's turnaround time);
    - Productivity (TEUs per year).

- Issues: traffic, congestion and capacity limits.

- OR techniques can improve the efficiency of terminal operations.

Terminal Overview

Terminal Operations

- Ship-to-Shore

  Berth Allocation; Quay Cranes Scheduling; Ship Loading Plan.

- Transfer

  Quay-Yard; Yard-Yard; Yard-Gate.

- Storage

  Yard Management (Block and Bay Allocation); Yard Crane Deployment

- Delivery and Receipt

  Gate management; Interface with trains and trucks.

In addition to the traditional flow: transshipment containers.

Vis and de Koster (2003); Steenken et al. (2004); Henesey (2006)

Issues in Yard Management

- The yard serves as a buffer for loading, unloading and transshipping containers.

- The yard is usually the bottleneck of the terminal: traffic, congestion and capacity issues originate from here.

- Crucial issue: the "schedule" of the outgoing flow is unknown to the terminal.

  - Import/export terminals: yard management is strictly connected to gate operations (trucks).
  - Transshipment terminals: yard management is strictly connected to mother vessels and feeders.

Transshipment: An Overview

- Containers are exchanged between mother vessels and feeders.

- Market players: the terminal interacts with big shipping companies and feeders.

- Peculiarities of the transshipment flow:
  - Arrival and departure positions and times can be known in advance;
  - Concurrency of loading and unloading operations.

- Definition of new transshipment-related problems:
  - Service Allocation Problem *(Cordeau et al., 2007)*;
  - Group Allocation Problem *(Moccia and Astorino, 2007)*.
  - Short Sea Shipping: Barge Rotation Planning *(Douma et al., 2007)*.

Transshipment: A New Approach

- Interactions of the terminal with the other market players:

  ▶ Negotiation between terminal and feeders on the arrival time.

- Global optimization vs hierarchical optimization:

  ▶ Simultaneous assignment of berths and blocks in the yard to the feeders.

- Control on crucial issues and objectives:

  ▶ Minimize the total distance quay-yard;
  ▶ Minimize congestion in yard blocks;
  ▶ Balance workload among yard blocks.

Transshipment: A New Approach

Research plan on 2 levels:

- Optimization framework:

  1. Berth & Block Allocation Problem (BBAP);
  2. Scheduling of feeders.
     - we assume that the terminal can decide the schedule of feeders;
     - iterative procedure to find a feasible scheduling.

- Negotiation framework:
  - Game theory;
  - Pricing policies and strategies.
    - we aim to support the terminal in its negotiation with feeders.

Berth & Block Allocation Problem (BBAP)

- We consider the flow of containers from one mother vessel to several feeders;

- We associate a container group to each feeder;

- Each container group must transit by a yard block and a berth;

- Capacity limits on space (blocks) and time (berths).

- ► We can associate a network to the problem.

The Transshipment Network
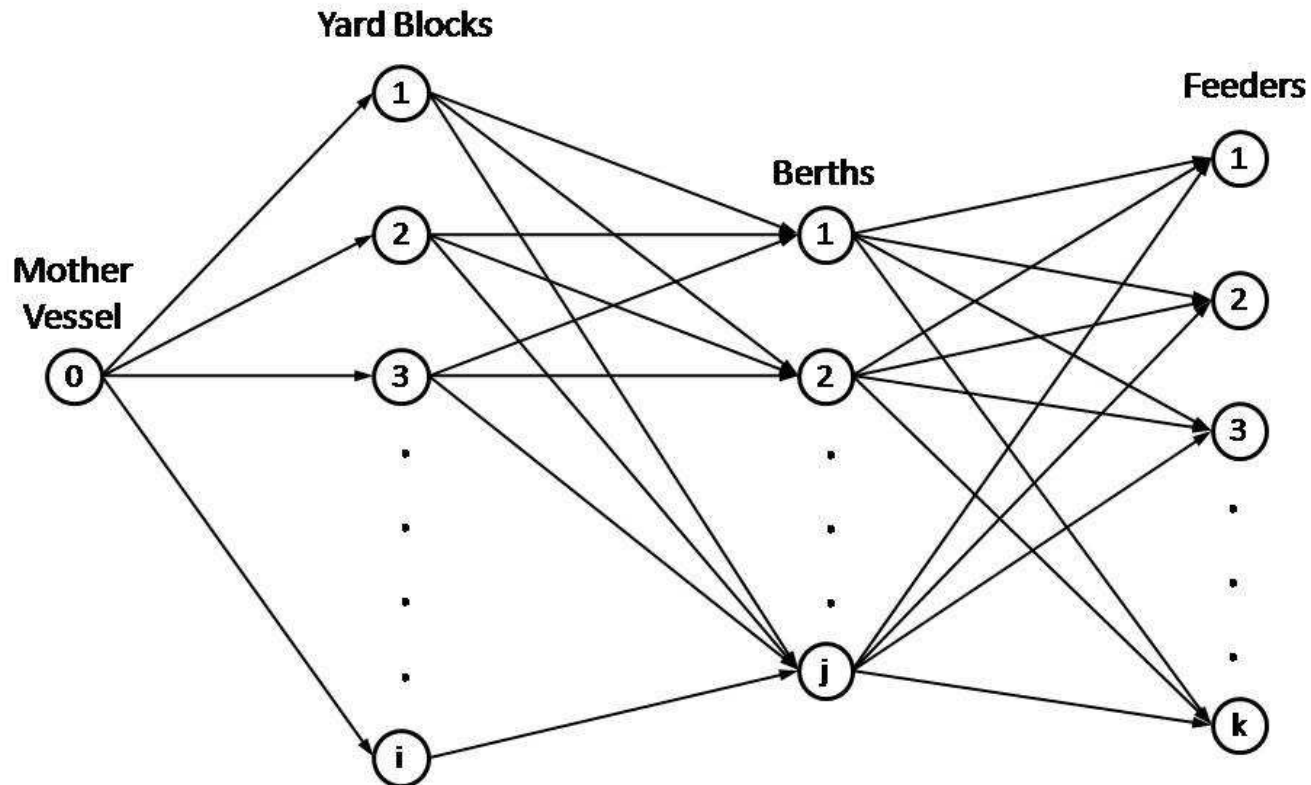
We can find the optimal berth-block assignment by solving a multicommodity flow problem on the transshipment network.

Conclusions

- Focus on yard management and its interactions with:

    - gate operations;
    - transshipment flow.

- A new approach in the optimization of transshipment operations:

    - combined assignment of berths and blocks to feeders (BBAP);
    - scheduling of feeders.

- Pricing policies to support the terminal in the negotiation with feeders.

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