

A capacity decision support model for synchromodal transport under uncertainty

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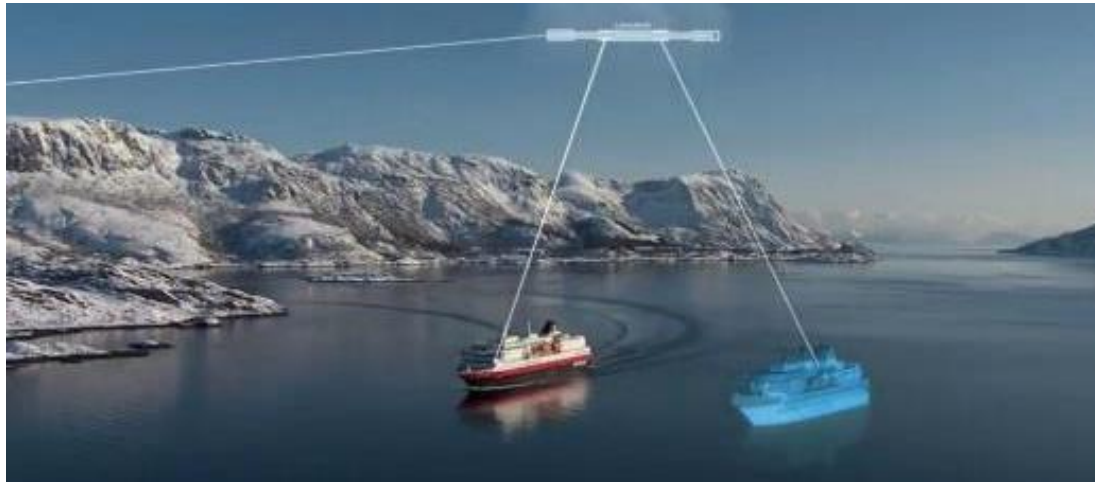
KNOWLEDGE IN ACTION

DISpATch project

- Digital twin for synchromodal transport
- Partners:



- Objective: Facilitate synchromodal transport



Source: mframe

Introduction

Support logistics service providers in their transition towards synchromodal transport.

Rationale:

- Increased freight consolidation
- Higher vehicle fill rates
- More environmentally friendly transport modes

Introduction

Support capacity planning under uncertainty from the perspective of LSPs

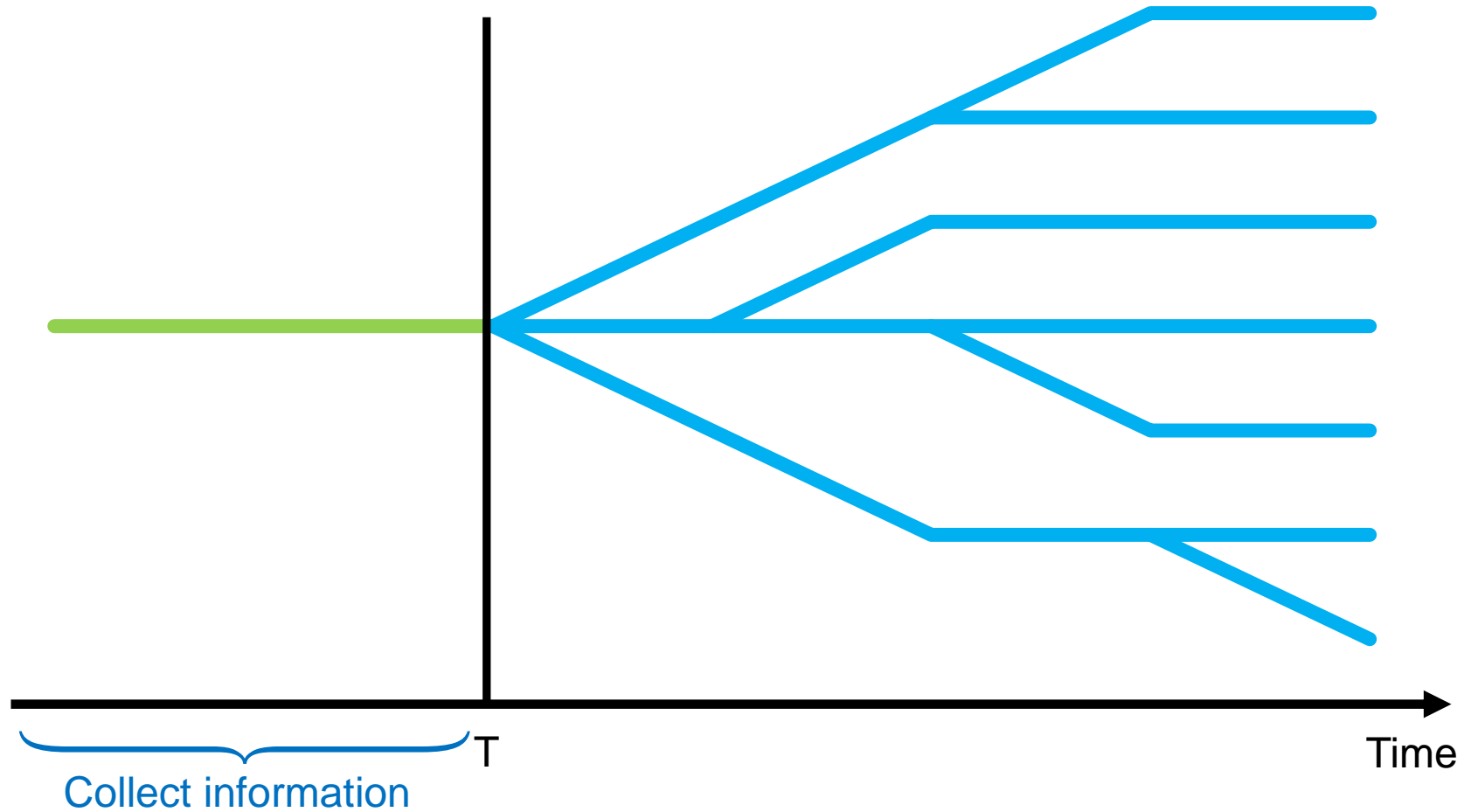
Only container transport

Scope: single corridor

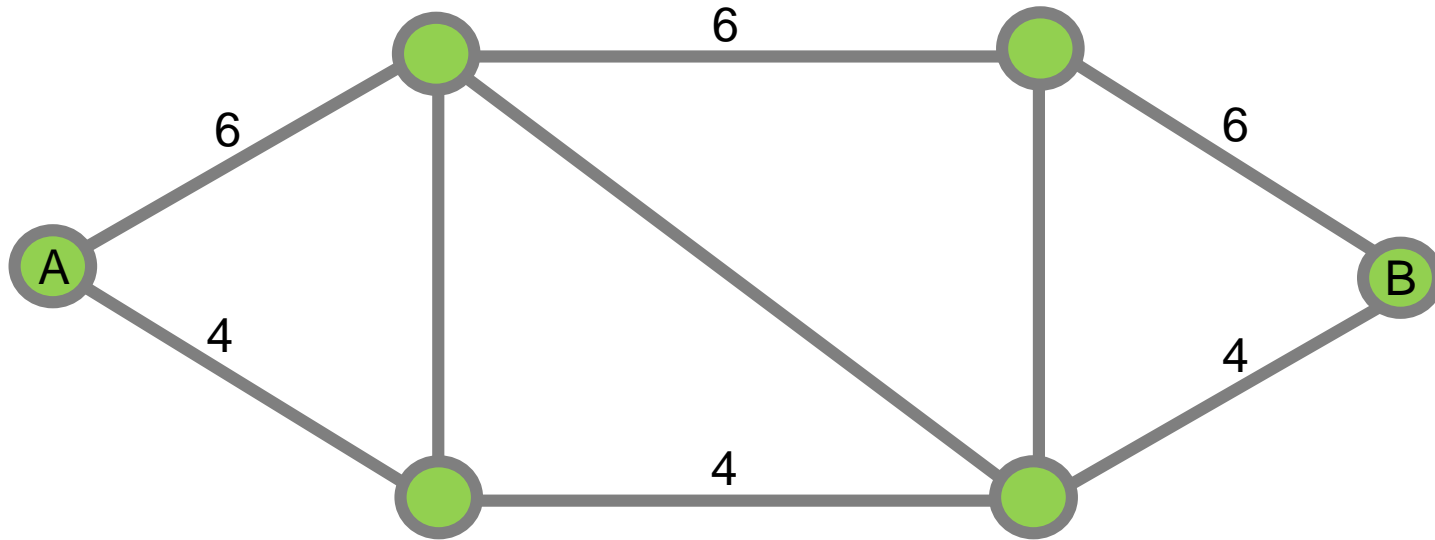


Source: European Rail Freight Association

Digital twin



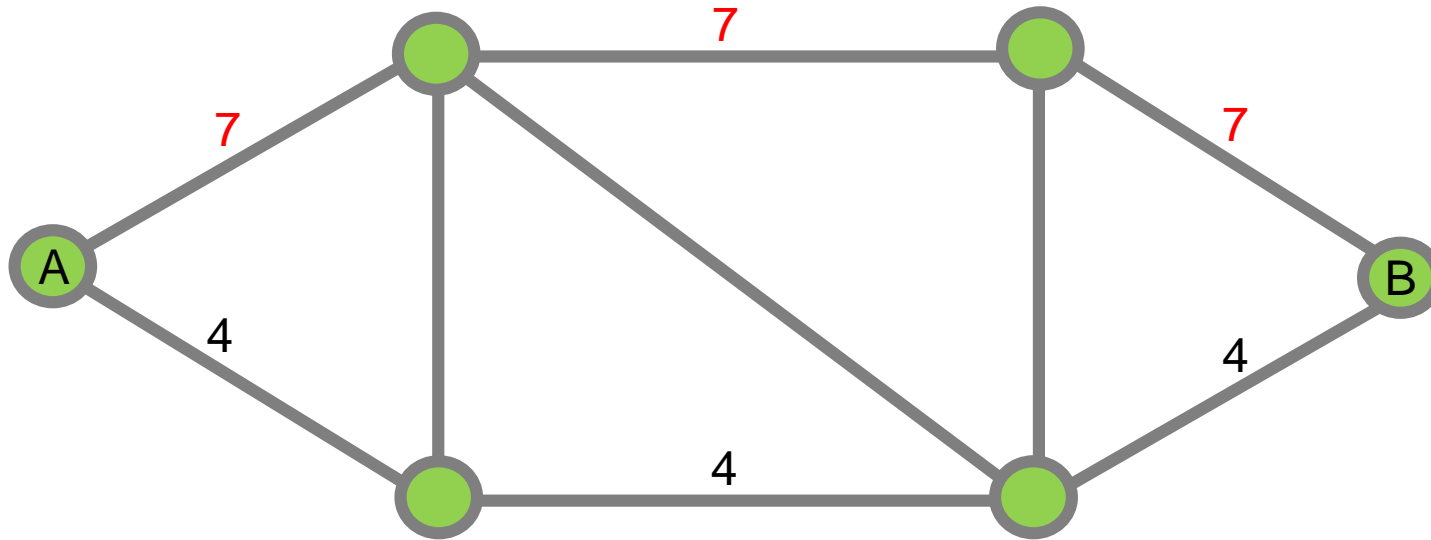
Transport planning



Tactical planning

- Capacity decisions

Transport planning



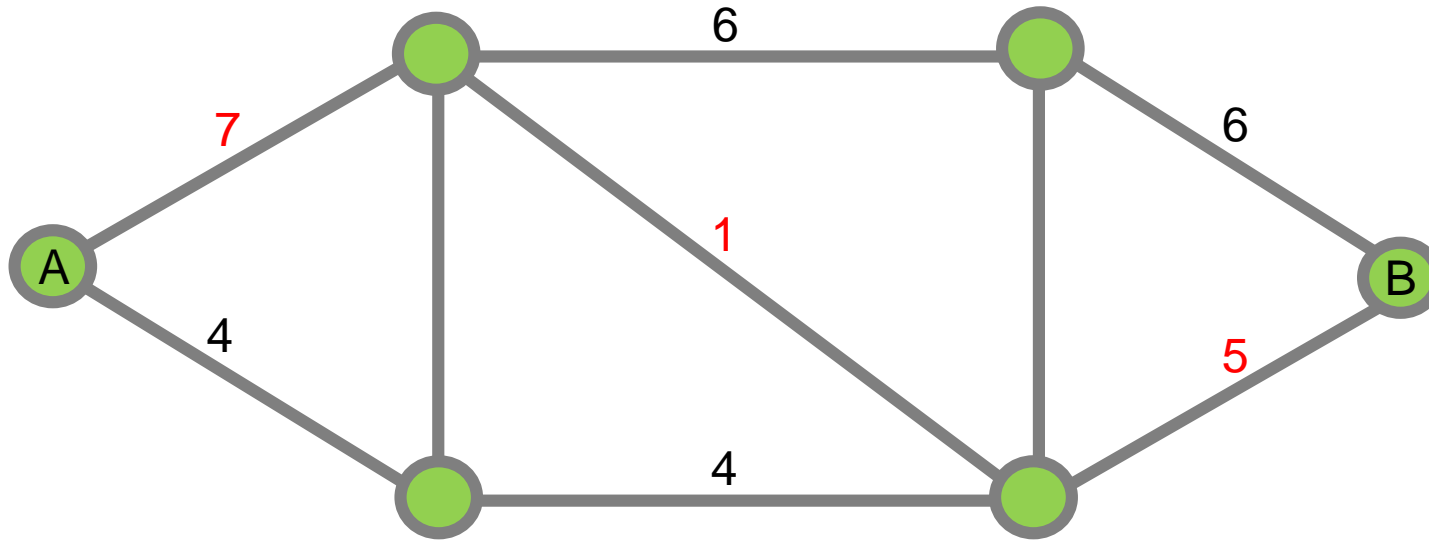
Tactical planning

- Capacity decisions

Operational planning

- Short-term capacity adjustments
- Container routing

Transport planning



Tactical planning

- Capacity decisions

Operational planning

- Short-term capacity adjustments
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Types of uncertainty

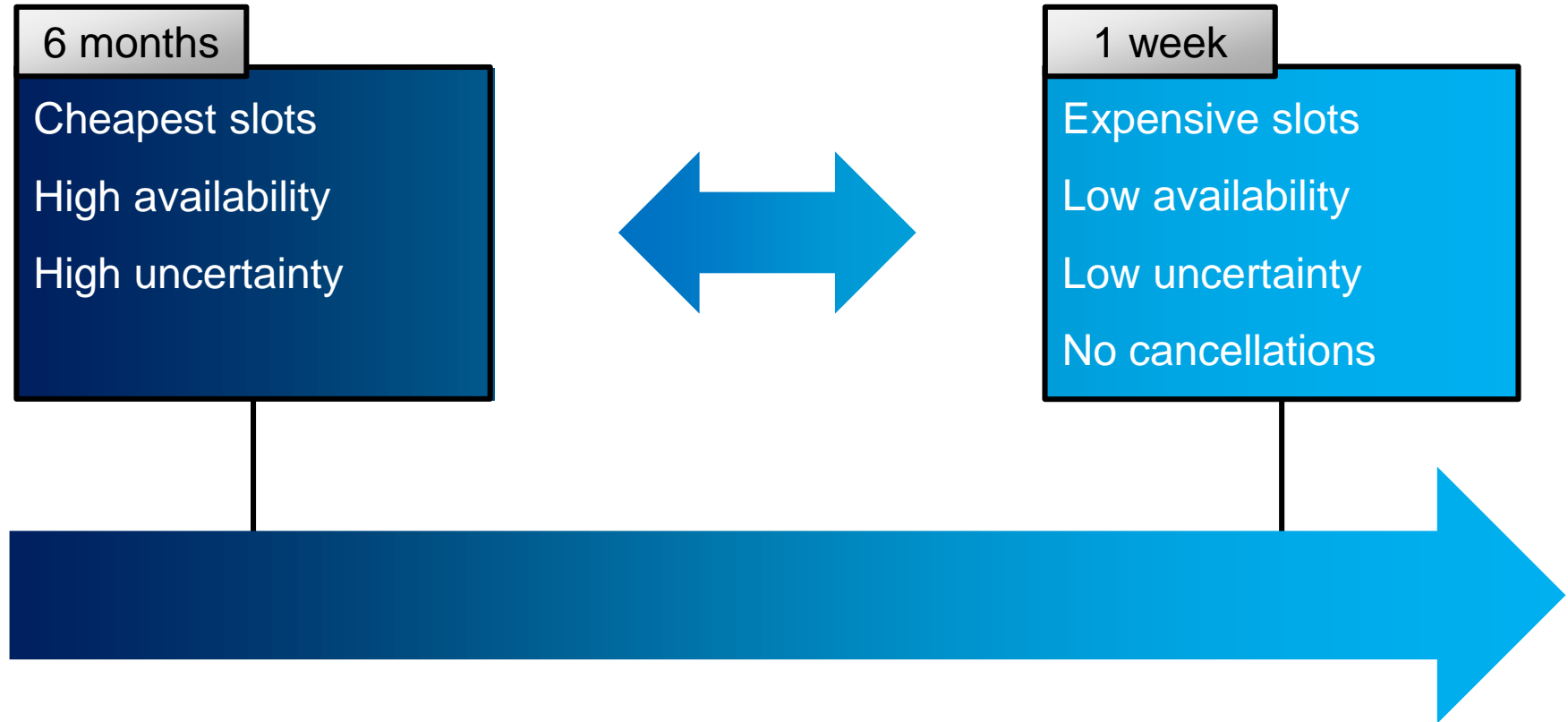
- Stochastic demand
- Stochastic travel times
- Remaining available capacity
- Deviations between actual capacity and booked capacity
- Sudden disruptions

Problem description

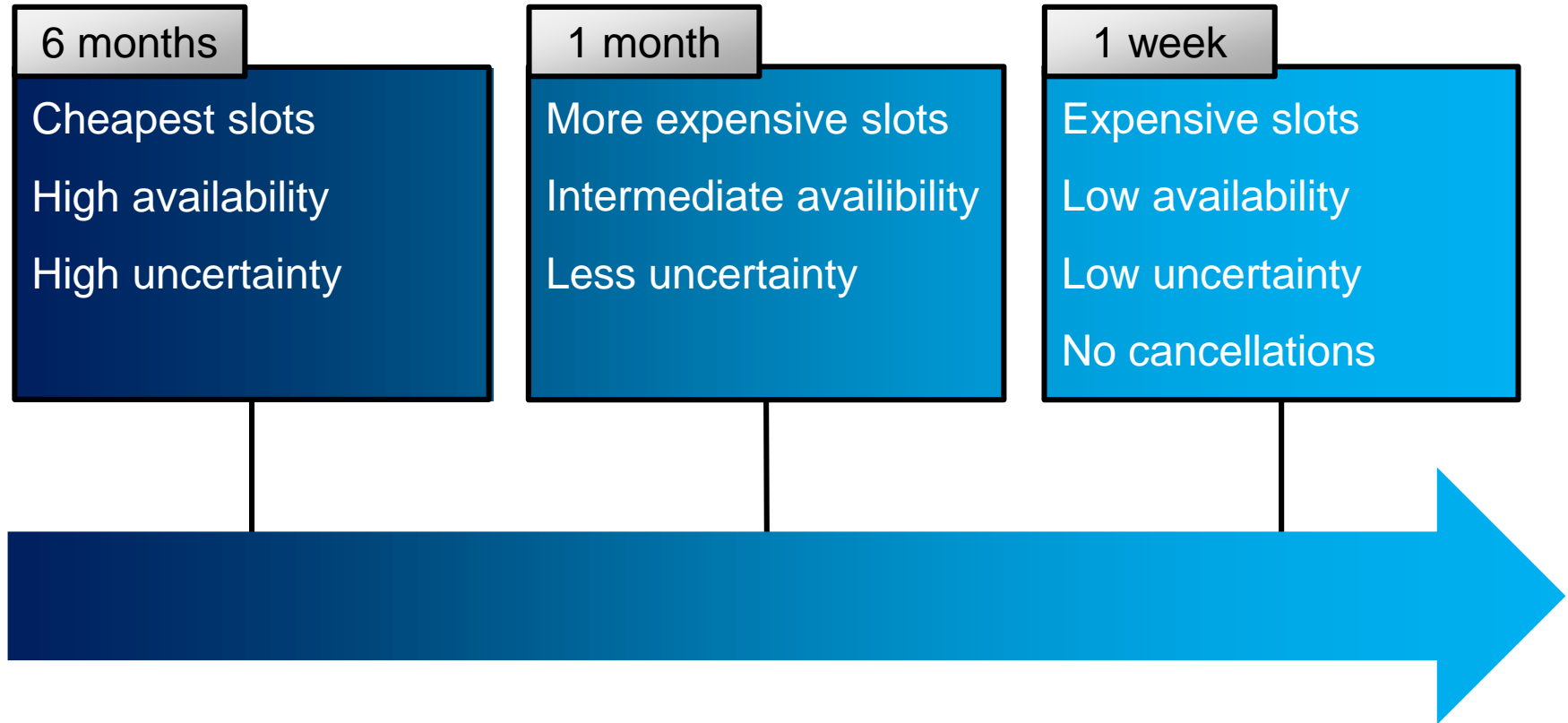
- Challenges faced by LSPs
 - How much capacity should be booked in advance?
 - How many trucks to keep?
 - How to deal with disruptions in real-time?
- Results from our literature review ¹
 - Service network design (SND) problem
 - Two-stage models

¹ Delbart, T., Molenbruch, Y., Braekers, K., & Caris, A. (2021). Uncertainty in Intermodal and Synchromodal Transport: Review and Future Research Directions. *Sustainability*, 13(7), 3980.

Planning timeline



Planning timeline



First stage

Objective function:

Minimise costs $\left\{ \begin{array}{l} \textit{Capacity costs in the first stage} \\ \textit{Expected additional capacity costs} \\ \textit{Expected penalty costs} \end{array} \right.$

Decisions variables:

Booked slots per service

Constraint:

Booked capacity \leq available capacity

Second stage

Decisions variables:

Booked slots per service

Cancelled slots per service

Constraints:

Extra capacity \leq remaining available capacity

Cancelled slots \leq previously booked slots

Third stage

Decisions variables:

Booked slots per service

Emergency capacity

Containers per order assigned to each service

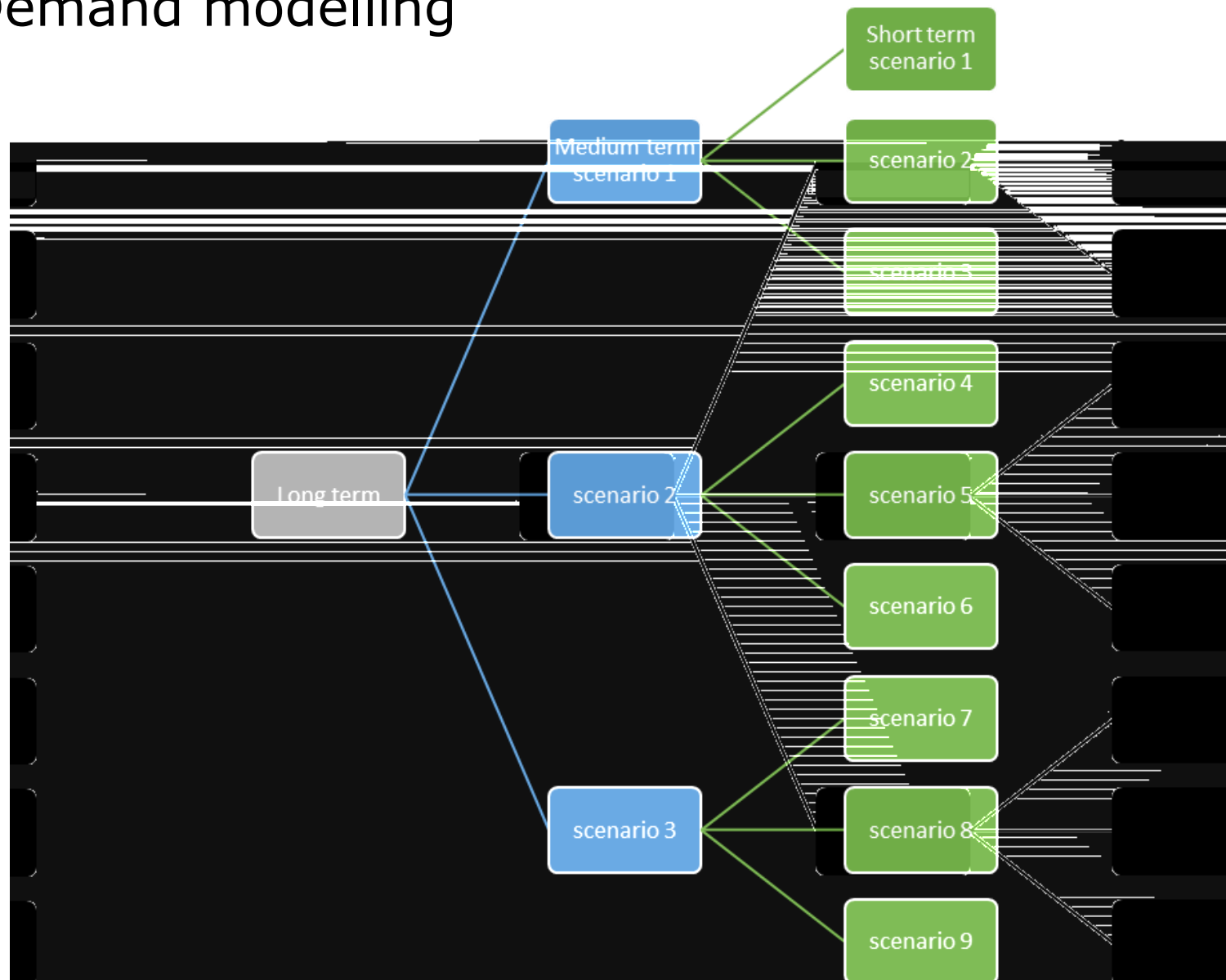
Constraints:

Booked capacity \leq remaining available capacity

Time window constraints

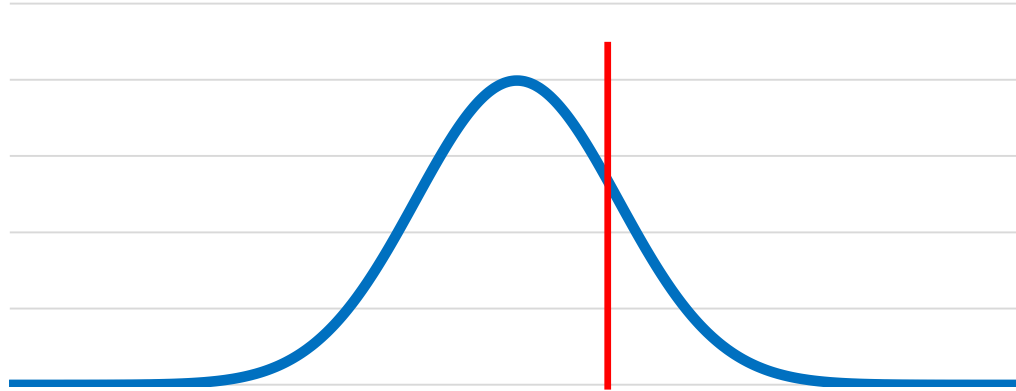
Flow conservation constraints

Demand modelling



Demand modelling

Long-term demand distribution



Medium-term demand distribution



Next steps

- Determine how to model demand
- Develop a solution method
- Apply the model with company data
- Expand the model with additional sources of uncertainty

Thank you

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