

# **A capacity decision support model for synchromodal transport under uncertainty**

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KNOWLEDGE IN ACTION

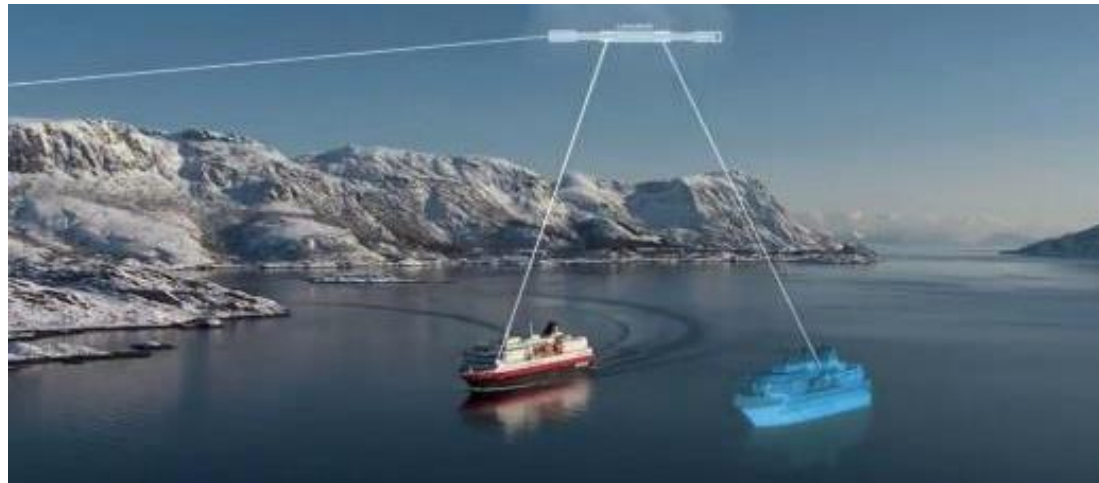


# DISpATch project

- 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

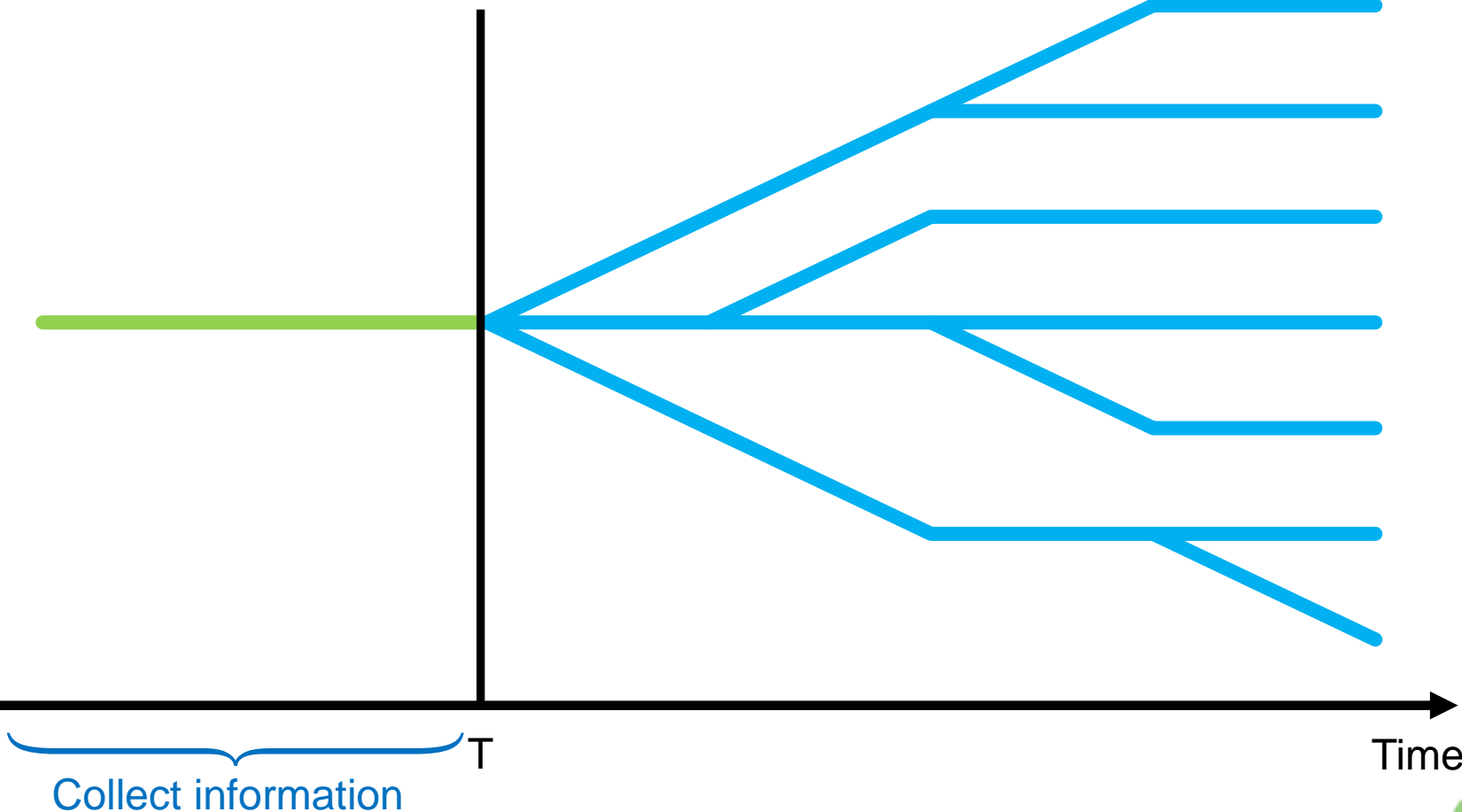
Only container transport

Scope: single corridor

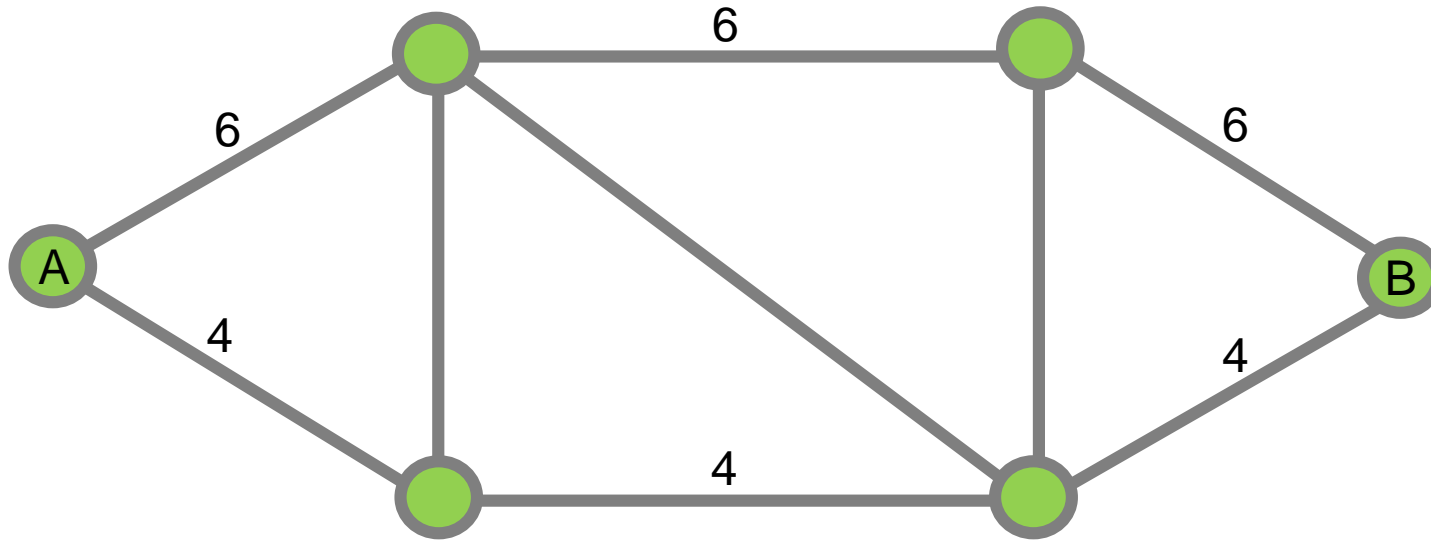


Source: European Rail Freight Association

# Digital twin



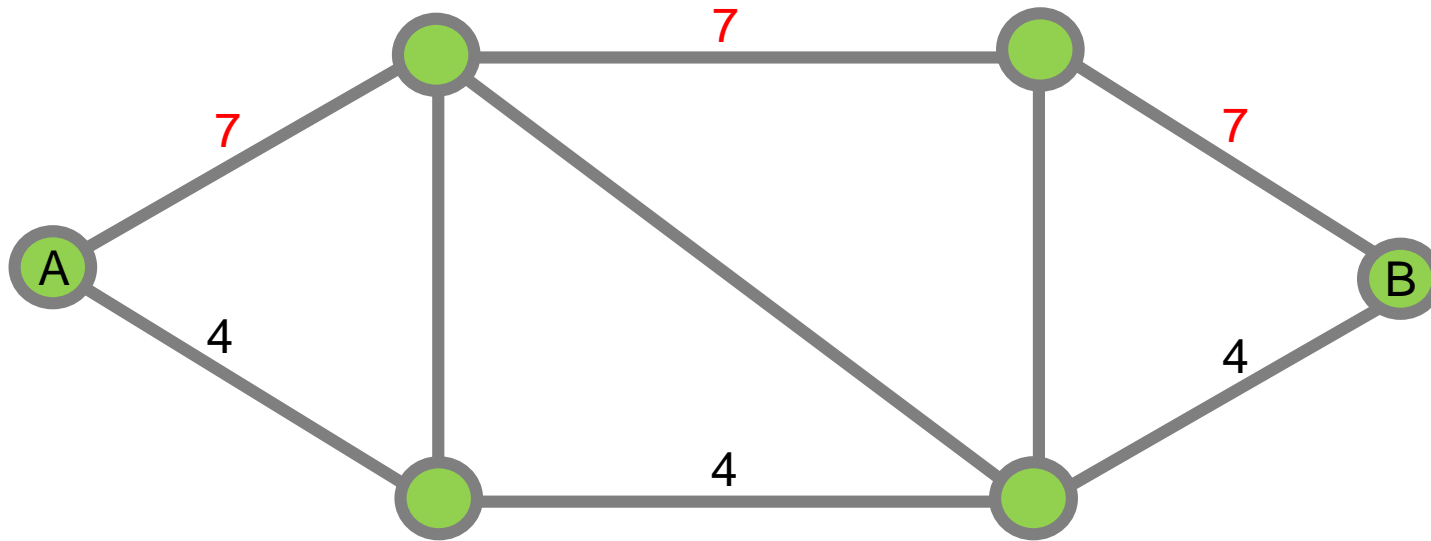
# Transport planning



## Tactical planning

- Capacity decisions

# Transport planning



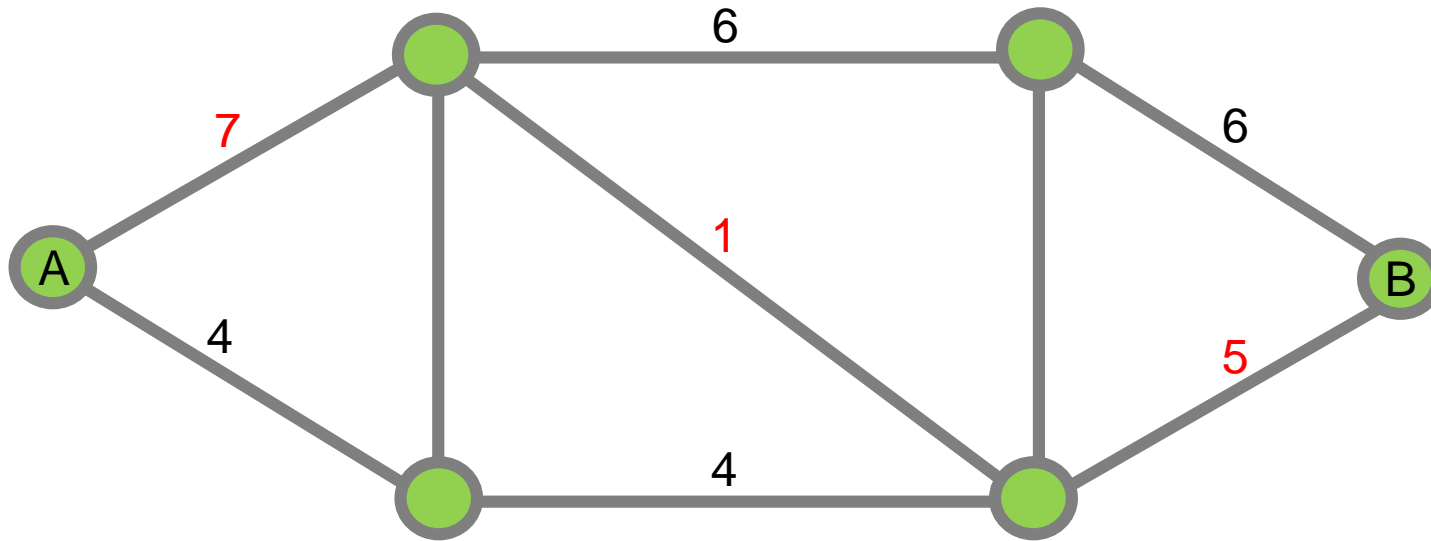
## Tactical planning

- Capacity decisions

## Operational planning

- Short-term capacity adjustments
- Container routing

# Transport planning



## Tactical planning

- Capacity decisions

## Operational planning

- Short-term capacity adjustments
- Container routing



## Types of uncertainty

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

# Problem description

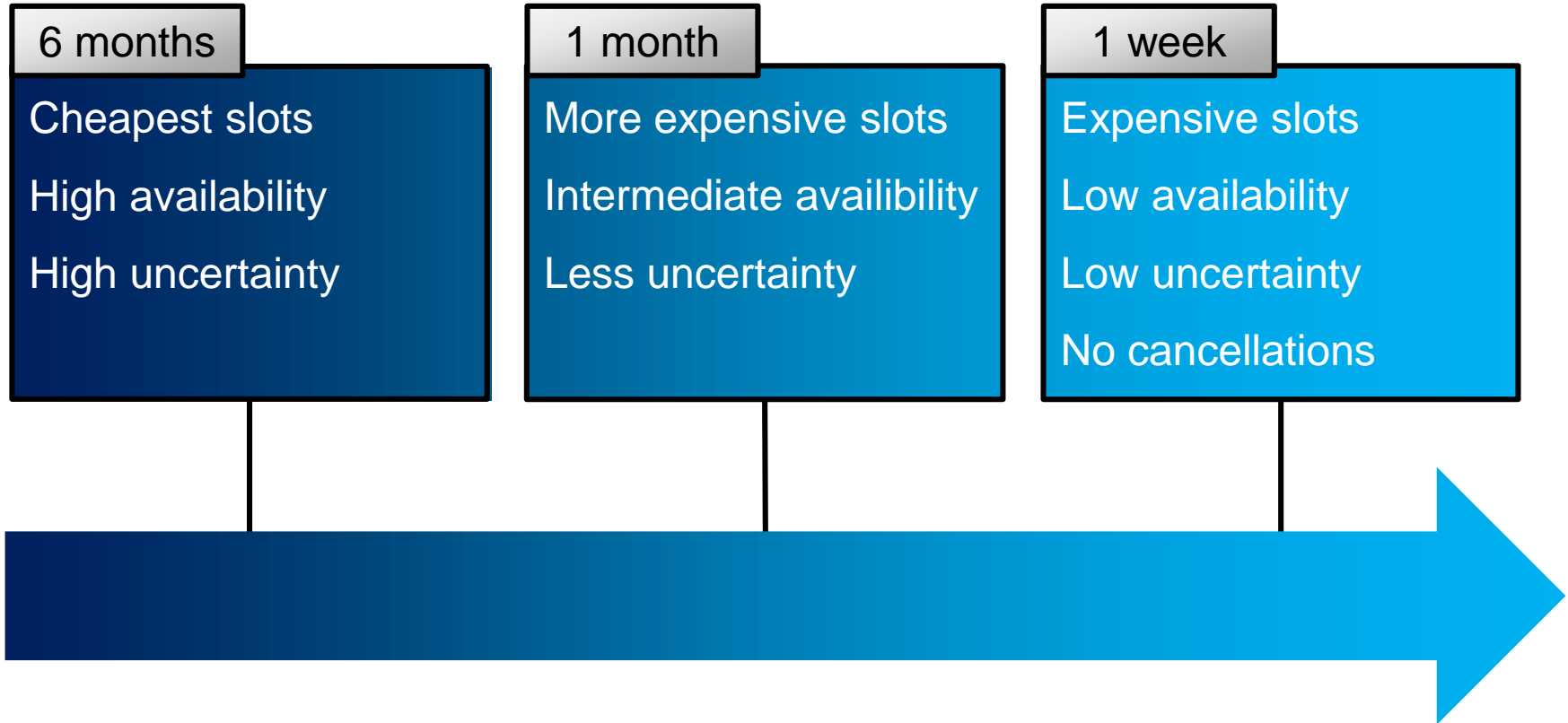
- Challenges faced by LSPs
  - How much capacity should be booked in advance?
  - How many trucks to keep?
  - How to deal with disruptions in real-time?
- Results from our literature review <sup>1</sup>
  - Service network design (SND) problem
  - Two-stage models

<sup>1</sup> Delbart, T., Molenbruch, Y., Braekers, K., & Caris, A. (2021). Uncertainty in Intermodal and Synchronomodal 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

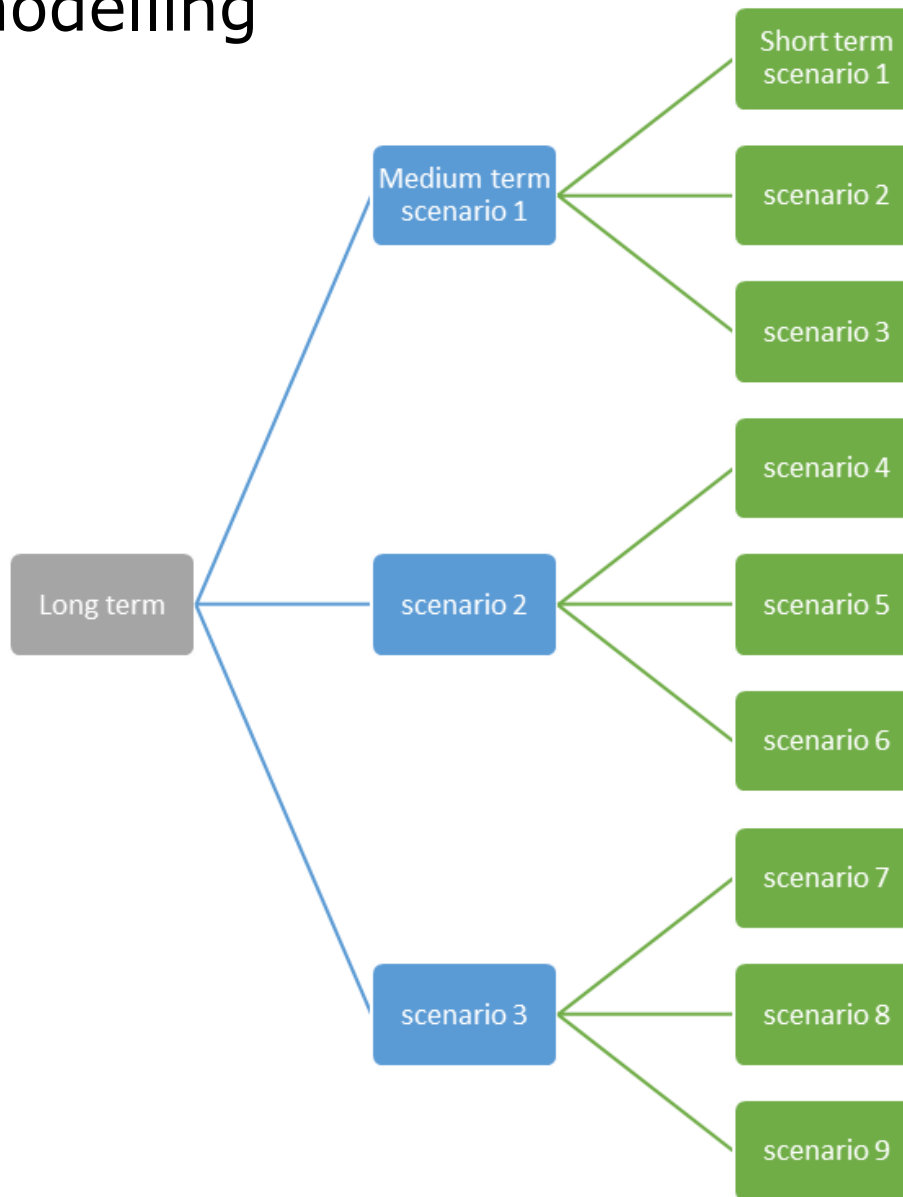
### Constraints:

Booked capacity  $\leq$  remaining available capacity

Time window constraints

Flow conservation constraints

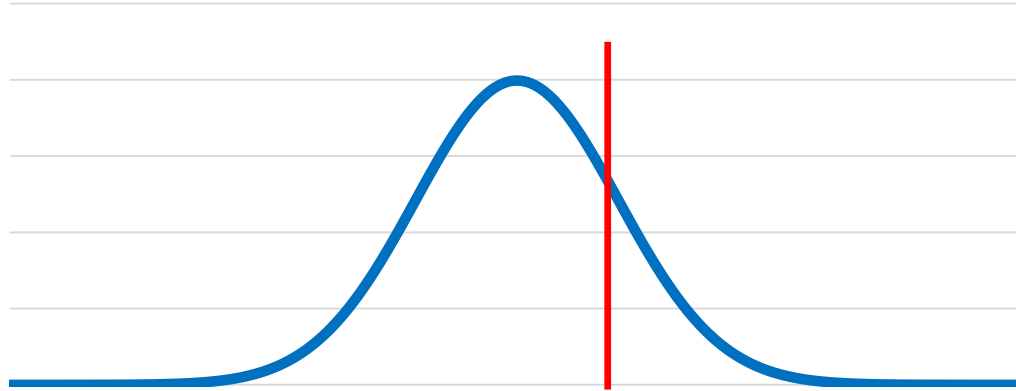
# Demand modelling





# 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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